The Dock and Harbour Authority

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Editorial Comments

The Journal in War-time.

Since writing the strangely premonitory comment for last month's issue on the contemporaneous celebration of anniversaries of the opening of the Panama Canal and the outbreak of the "Great War" of 1914, the impending and dreaded storm of a fresh major war has burst on the nation with startling suddenness, and large areas of Europe are now involved in a welter of carnage and slaughter. We shall not attempt to dwell on the war's fiercer manifestations: they are only too familiar from accounts by wireless and in the press.

A word or two, however, is necessary on one of its less important but inevitable repercussions. It is obvious that information respecting British ports which might, if it reached enemy circles, be prejudicial to the safety of the nation, cannot now be published, and that all statements of whatever kind are subject to the strictest censorship. Needless to say, we have no wish to avoid this legitimate scrutiny, but our readers will realise that it places the Journal in a position of extreme difficulty. We must, therefore, invite their sympathetic consideration for the attenuated service which is all that we can render them during this period of national emergency. We shall endeavour to keep the flag flying: we believe that the Journal has proved its usefulness during the extended period of its publication, and that it would be a matter for regret in many quarters if it failed to survive. But if it is to be kept going, there will be need for the exercise of patience and good will on the part of subscribers and advertisers, whose help, greatly appreciated in the past, will be more than ever invaluable at the present time. We confidently appeal for their continued support.

For obvious reasons, the issue of Illustrated Supplements, giving plans and details of ports in their local setting, has had to be suspended, but we hope to resume the series in a not too distant future. Meanwhile, we are endeavouring to furnish articles of a character which, while avoiding dangerous and forbidden ground, will be of interest and service in the prosecution of activities at British ports.

Port Emergency Committees.

On another page in this issue will be found extracts from the Defence Regulations, recently issued for the Control of Traffic at British Ports. In connection therewith, the Minister of Transport has appointed at each of the leading commercial ports of this country a Port Emergency Committee to act on his behalf, and to give effect to the necessary measures for the efficiency of port operation. The Committees have been assigned wide discretionary powers, and they will be able, wherever circumstances justify it, to prevent undue congestion of traffic by the imposition of penalty rents and by the forcible removal of goods to other places of storage. Each Committee is composed, in general, of representatives of the port authority concerned, of shippers, of traders, of labour and of all sections of transport interested in the service of the port.

One of the most glaring evils in the conduct of the last war was the confusion caused by congestion at ports, and it has been urged in this Journal on more than one occasion that special attention should be directed to the means for avoiding it in future hostilities. The appointment of these port emergency Committees at an early stage, therefore, is wise and timely, but it is a matter for regret that so little heed has been paid to the plea for a recognition of the valuable assistance which could be rendered by an effective system of inland waterways, as an adjunct to rail and road services. It is, we fear, too late now to take steps of a drastic character to bring the canals and waterways of this country as a whole up to the standard necessity for conditions of modern transport, though there are admittedly striking exceptions, where improvements and developments in recent years have done much to rectify previous deficiencies.

Germany, needless to say, is making full use of the magnificent network of internal waterways which has been constructed in that country during the past decade. These waterways are now proving their value in relieving the pressure on other means of transport. They form a most important part of the war-time machinery of operations.

The Cardiff Dock Centenary.

By reason of the present anxious state of national affairs, the centenary commemoration of the opening of Cardiff's first dock was held on 20th September, in an atmosphere of subdued, but no less heartfelt, gratification at the remarkable record of successful progress which has characterised the city and port during the past hundred years. In a quiet, but impressive, ceremony, recorded elsewhere in this issue, tribute was paid to the initiative and courage of the second Marquis of Bute, to whose enterprising activity so much of the present development of the trade of the port is due, and to the fostering care of his successors in the administration of the town and port.

As was pointed out by the Lord Mayor, who took the leading part in the ceremony at the Great Western Railway Company's office, Cardiff, a town, 100 years ago, of only some 10,000 inhabitants, mainly interested in the agricultural pursuits of the adjacent countryside, has become a city of almost a quarter-of-a-million people and has risen to heights of industrial and manufacturing importance, with ramifications of overseas trade and commerce extending to the furthest limits of the civilised world. Local coal which was looked upon in the latter half of the eighteenth century as an impracticable commodity, has become the staple export, ranging among the chief items of national trade, while the manufacture of iron and tinplates has likewise achieved a position of commanding importance.

We offer respectful congratulations jointly to the municipality and the Great Western Railway Company on the striking and continuous expansion of the shipping accommodation at the docks, which our readers will recall have been fully described, with an illustrated supplement, in our issue of July, 1938.

German Ports and the War.

The supremacy of the British Navy has had an immediate effect on German overseas commerce. German merchantmen and passenger ships, as well as German surface warships, have been swept from the traffic highways of the world, and the former have had to seek hurried refuge in neutral ports, where they will perforce remain interned for the duration of the war. The "Europa" managed to reach her home port just in time, and the "Bremen" is in hiding, but other and less fortunate vessels have been captured, or sunk.

With the loss of their shipping and the imposition of a naval blockade, German ports have inevitably felt the consequences of the mad policy of their Government. As in 1914, the great Port of Hamburg, together with the adjacent ports of Bremen, Bremerhaven and Cuxhaven, fronting the North Sea, lie in a

Editorial Comments—continued

state of suspended animation. Their quays are no longer thronged with busy stevedores and porters, engaged in the discharge and loading of cargoes. In a short time they will become bare and deserted, their quay cranes and transporters idle, and their trade at a standstill.

Sic transit gloria " muende " (of the Elbe and the Weser).

The Port of Danzig.

The Free City of Danzig has stood out so prominently in the international situation for months past, that it seems appropriate to make some reference in these columns to its activities as a port and shipping centre, since it is in this respect that it acquires its peculiar importance as a political pawn. For her overseas commerce, Poland has been dependent on a single narrow strip of territory forming an approach to the Baltic Sea, generally known as the Polish Corridor, the actual gateway of which is the modern Port of Gydnia. But Danzig at the adjacent mouth of the River Vistula is no less important as the outlet of an avenue of water-borne trade leading to the centre of Poland and South-Eastern Europe. These two ports are, therefore, a matter of vital concern to Poland, if she is to be anything more than an land-encircled country like Switzerland or Hungary, without foreign trade of any significance.

Gdynia has already formed the subject of two illustrated articles in this Journal, the latest of which appeared as recently as January, 1936. There is, accordingly, no occasion for further description at the moment. On the other hand, Danzig has not hitherto received special notice. Some observations on its trade and leading features will therefore be of interest.

The city stands on the left bank of the Western arm of the Vistula, about four miles South of the outfall of the river into the Baltic at Neufahrwasser, which constitutes an outer, or advance, port. For this length of four miles, the Vistula is navigable by ships drawing 30-ft., while in the City of Danzig itself, which is intersected by two branches of the Mottlau, a tributary of the Vistula, there is an available depth of 15-ft. to 16-ft. alongside the quays. Neufahrwasser has an entrance depth of 33-ft.

The harbour and waterways have, until recently, been administered by a Commission composed of five nominees of Danzig and Poland under a President, who, constitutionally, must be of Swiss nationality, and appointed by the League of Nations, if Danzig and Poland fail to come to an agreement on the matter. The area of the harbour has been so defined as to include a portion of the town.

The trade of the port is miscellaneous in character. Exports are chiefly timber, coal, naphtha, sugar, spirits and cement. Imports include herrings, fertilisers, provisions, machinery, ores, tobacco, cotton and wool. In the past, there was an important trade in amber.

There is a Free Port or Zone with 2,000 lin. ft. of quayage and accommodation for a dozen vessels. A new basin has recently been formed at Wechselmunde for coal and iron ore: it is equipped with belt conveyors and bridge cranes. For general merchandise, there are numerous quay cranes up to 8 tons in capacity.

The City has a quaint, mediæval aspect, some of the buildings dating from the 16th and 17th centuries, when it was an important member of the Hanseatic League. We spent some few hours one Sunday afternoon, three years ago, in admiring, among other features, the decorative patrician houses and buildings in the Lange Gasse, or main thoroughfare, as also those in the more secluded Frauengasse, with their ornamental gables, stone terraces and flights of balustraded steps leading to the pavement. One particular feature which impressed itself upon our memory at the time was the persistency with which Nazi party collectors in the streets rattled their contribution boxes, thrusting them on the attention of every passer-by. Indications were not wanting that the contributions were made in a number of cases with reluctance.

Dry-Docking Facilities at Capetown.

The need for a large, up-to-date dry dock at Capetown has long been the subject of vigorous advocacy in commercial and shipping circles at the capital of South Africa, where the great harbour development scheme is rapidly progressing towards successful accomplishment. The announcement made some year or so ago by General Hertzog, at that time Prime Minister of the Dominion, that a survey for a site was to be begun, almost implied that the Government had decided in principle on the construction of a dry dock, which was understood to be of the order of at least a 1,000-ft. in length, with a view to making provision for the most modern class of vessel likely to visit the port. Since then, however, the matter has been in abeyance, apparently from financial considerations, seeing that of necessity the outlay would be considerable.

The advocates for the immediate construction of the dock have chafed at the delay, and the South African Press has been the field of much controversy on the subject. The matter was raised in the House of Assembly in June, when Mr. Musket called attention to the absence from the loan estimates for the year of any sum allocated to the promised " survey." He pointed out that "Australia had eight dry docks against one antiquated dry dock at Capetown and an up-to-date dock at Durban." India, he said, had no fewer than eighteen dry docks. Shipowners visiting Capetown had called attention to the lack of dry-docking facilities, and he made a plea for prompt action on the part of the Government in order to foster the expansion of trade by South African shipping routes instead of through the Mediterranean.

Senator Fourie, in his reply, stated that the Administration had been unable to come to a decision in favour of the proposed additional dry dock. All that had been done was to authorise a survey. This was being proceeded with, and the Administration would have to be entirely satisfied both as to the necessity for a dock, and that it could be constructed at a reasonable cost before the undertaking would be embarked upon. He contended that in Australia there was only one dry dock capable of accommodating the new " Dominion Monarch," the latest vessel in the South African Service. There was a dry dock at Durban—" only 700 or 800 miles from Capetown "—which was large enongh for the purpose and, in addition, a dry dock at Simon's Town, which he was informed could be utilised.

It scarcely seems an adequate reply to the agitation for a dock at Capetown to say that a dry dock " 700 or 800 miles away " suffices to meet all requirements. The distance in itself is sufficiently formidable, and in the case of a vessel war-damaged, and urgently needing repair, it might prove disastrously far. Most ports of shipping importance consider it essential for their prestige, no less than for their current requirements, to be able to meet the demands of ships which visit their ports. That there is every reason for caution in State expenditure will be freely admitted, but there is a point at which excessive caution stifles reasonable enterprise and proves a bar to legitimate progress. Capetown has committed itself to the construction of a fine, commodious harbour; it would be lacking in foresight and sound judgment if it did not at the same time see that the harbour was well appointed and adequately equipped in every respect for any demands likely to be made upon it. War-time conditions will, undoubtedly, affect the situation temporarily, but the long view should prevail and provision be made accordingly.

A New Graving Dock for Belfast.

While on the subject of dry docks, it is to be noted that a plea for a larger graving dock at Belfast was made by Mr. F. E. Rebbeck (Chairman of Harland and Wolff, the well-known firm of shipbuilders) at the luncheon following the launch of the aircraft carrier " Formidable," towards the end of August. Mr. Rebbeck said that there was one thing required to make Belfast " a really big naval port," rendering it unnecessary " to worry about Portsmouth or any other naval dockyards," and that was a large dry dock to serve the needs of " lame ducks of the Fleet " when they required succour. As in the case of Capetown, so also in Northern Ireland, there can be little doubt that the availability of a dry dock to meet the immediate requirements of all vessels, mercantile as well as naval, especially under war conditions, is an asset of the greatest importance, and ports which are inadequately equipped in this respect are likely to find themselves outclassed by neighbouring ports where such facilities are more readily obtainable.

Panama Canal Locks.

In the issue of this Journal for April last, attention was directed to the movement in the United States for the construction of a Ship Canal through the Isthmus of Panama by an alternative route, and the project of a Nicaraguan Canal was discussed. The main argument advanced in favour of the scheme was the liability of a single canal to abrupt blockage by the destruction or the obstruction of one of the locks in the narrow waterway.

The United States Congress, in order to meet this contingency, has since decided on the duplication of the present lock system on the Panama Canal, and it is now announced that the work is to be proceeded with immediately. The new locks are estimated to cost 277 million dollars. They will materially increase the capacity of the canal to meet the demands of a rapidly growing traffic as well as making provision for the hazards of war. They will be arranged as a series of by-passes parallel to the main line of the canal, at a distance of a quarter to half a mile from the existing locks. The chambers will be 1,200-ft. long by 135-ft. wide, and the depth over sills will be 45-ft. The approach channels will be 300-ft. wide with a minimum depth of 40-ft.

Panama Canal traffic during July last, included 485 ocean vessels, paying tolls amounting to $1,974,380, compared with 429 vessels and tolls of $1,694,205 during the same month last year. Traffic during the first seven months of this year totalled 3,545 vessels, paying tolls of $14,316,512, compared with 3,212 vessels, and tolls of $12,983,870 last year.

The Port of Southampton*

A Great Passenger and Trading Port

By R. P. BIDDLE, M.Inst.T.,
Docks and Marine Manager, Southern Railway

(Continued from page 316)

Passenger Traffic

Southampton has been used for the embarkation and disembarkation of passengers since the earliest times, but with the tremendous expansion in travel during recent years it has attained a foremost position in the world in this respect. Distinguished as Britain's premier gateway for ocean travel, it has also achieved a high reputation as a cross-channel port and as a centre for pleasure cruising and trooping activities.

Most parts of the world are now linked up with Southampton, and at present there are 21 shipping companies providing regular passenger communication with the United States of America, Canada, Africa, South and Central America, Far East, Australia, New Zealand, Dutch East Indies, West Indies, Channel Islands and Continental countries.

Southampton's development as a passenger port has been largely due to its physical advantages. A sheltered approach from the sea, deep water, and the absence of tidal and locking difficulties have proved of particular value in the manœuvring of large liners and in preventing delay in disembarkation. A further factor is Southampton's central position on the South Coast within easy access of London and the Continent. British liners to and from Southampton can conveniently call at a Continental port to embark or disembark passengers, and similarly, French, German, Dutch and American liners can include a call at Southampton with no great deviation of route.

So far as the docks are concerned, facilities have been provided for the convenience of passengers and for their expeditious movement between train and ship. The reception sheds where the Customs examination is conducted are situated close to berths and are supplied with postal, telephone, cable, baggage, and other services.

A notable feature of the spacious reception sheds at the docks extension is the inclusion of tastefully-decorated buffet-lounges and writing-rooms for the use of passengers and their friends.

When liners do not come to a berth at the docks, but embark or disembark their passengers off the Isle of Wight, a fleet of well-equipped tenders is available to convey passengers, baggage and mails between the liners and the docks.

The great development that has occurred in the passenger traffic at Southampton in recent years may be judged from the figures given below. In studying them it should be understood that they relate only to the docks. Traffic dealt with at the Royal Pier will be considerated separately.

Passengers embarking and disembarking at Southampton Docks:—

Year	In	Out	Total
1922	165,205	190,905	356,110
1926	195,425	253,633	449,058
1930	259,125	285,321	544,446
1934	239,437	244,637	484,074
1937	299,478	322,433	621,911

The traffic represented by the figures quoted is roughly divisible into two halves—ocean and cross-channel. According to the latest Board of Trade figures, Southampton deals with 44 per cent. of the total number of passengers travelling by sea to and from places outside Europe.

The most important branch of the ocean passenger trade is the traffic to and from the United States and Canada, which accounted for 23 per cent. of the total docks' traffic in 1938. So far as the movements between the United States and Great Britain are concerned, nearly two-thirds of the total number of passengers pass *via* Southampton Docks.

Second in importance in the ocean passenger trade is the South African traffic. Almost all the passengers travelling between this country and South Africa pass *via* the docks, and in 1938 over 40,000 passengers were dealt with.

There is also a large traffic conveyed to and from South America, Australia and New Zealand.

Southampton's position in relation to Continental travel may be realised from the fact that in 1938 over one-half of the entire passenger traffic at the docks represented movements between this country and France, Germany, Holland and the Channel Islands. The greatest activity is experienced in the summer in connection with the enormous holiday exodus to Jersey, Guernsey and St. Malo, and the services have to be considerably augmented. During 1938 the number of passengers carried on these holiday routes and on the Havre service was 286,076.

An interesting phase in the passenger trade of recent years has been the development of pleasure cruising, and Southampton, as the chief centre of ocean travel, also ranks as a leading cruising port. The highest number of cruise passengers ever dealt with at the docks was 108,396 in 1935.

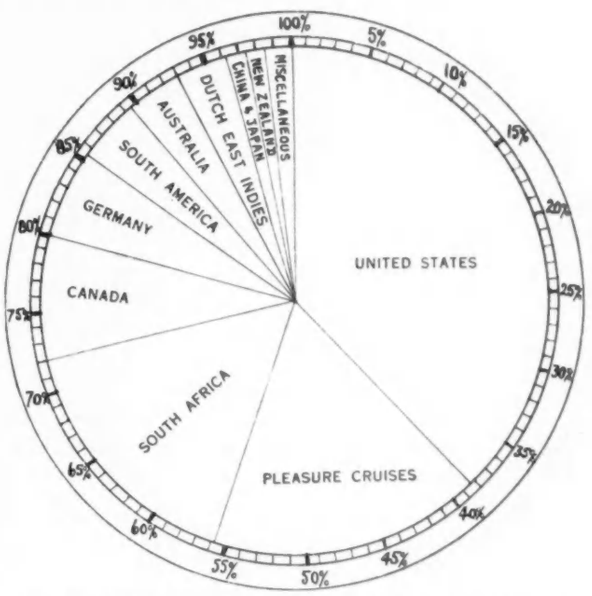


Fig. 3. Southampton Docks. Ocean Passenger Traffic, 1938

A passenger activity of a specialised nature with which the port has been prominently connected for many years is the embarkation and disembarkation of troops. During the months September to April, several of H.M. transports are specially commissioned for the conveyance of large numbers of sailors, soldiers and airmen principally to and from the Mediterranean and Far East. The traffic naturally varies from year to year in accordance with service requirements, but an idea of its extent may be gained from the fact that, in 1938—89,344 troops were dealt with. The capacity of Southampton in this respect was fully demonstrated during the Great War, 1914-1918, when upwards of 7,000,000 officers and men passed through the docks.

As has been mentioned, a considerable passenger traffic apart from the docks is centred at the Royal Pier. This is largely a seasonal trade, built up by holiday-makers and excursionists. In addition to a service to Cowes, Isle of Wight, special services and trips are run to other parts of the Island, to South Coast resorts and to Cherbourg during the summer months. Last year the total number of passengers embarked at the Royal Pier was 270,806. A few passengers are also dealt with at the Town Quay during the summer in connection with the Glasgow and Belfast coastal services.

Since the beginning of 1937 the port has assumed a new rôle as the British terminal for Imperial Airways flying-boat services to Empire countries. Originally, there were two services a week to Alexandria, but the development of the scheme to carry first-class mail by air, coupled with the steady increase in the number of passengers carried, has necessitated three services a week to Australia, three to Africa and two to India, with a corresponding schedule in the reverse direction. To operate this programme, a fleet of 36 flying-boats with a maximum speed of 200 m.p.h. is employed. Each can accommodate 15 passengers and 3 tons of mail. Egypt is reached in 1½ days, Central Africa and India in 3 days, South Africa in 5 days, and Australia in 8 days.

*Paper read at Southampton on June 16th, 1939, at the Congress of the Institute of Transport, and reproduced by permission from the Journal of the Institute.

Port of Southampton—continued

Further experimental air mail services to America across the North Atlantic are to be operated this summer, and it is hoped that a regular service will be possible in 1940.

The traffic carried on the Empire air routes has shown considerable development, as the following figures, covering the first two years of operations at Southampton, will testify:—

	1937	1938
Passengers	3,715	4,676
Mails (packages) ...	39,517	85,036

Direct embarkation or disembarkation of passengers from flying-boat to quay, or *vice versa*, is now carried out at Berth 108, Docks Extension, where Imperial Airways have their offices and station, and it is noteworthy that Southampton is the first of their marine air bases to attempt this procedure.

The Southampton Harbour Board, with the support of the Government, have promoted a Bill in Parliament to establish a marine air base at Southampton for flying-boat services. An area in Southampton Water, off Netley, one mile long, 1,200-ft. wide, and approximately 1,000-ft. to the east of the main shipping channel is to be reserved for the exclusive use of aircraft.

Conclusion

An effort has been made to present, within the limits of a short paper, the ever-changing life in the development of a great port, the modern history of which has been built up within the comparatively short period of one hundred years.

I trust that I have been successful in setting forth clearly an example of a great port and dock undertaking, in which human enterprise has harnessed the advantages conferred by nature and turned them to the benefit of mankind in general and commercial enterprise in particular.

The Discussion

Mr. D. Ross-Johnson, C.B.E. (a former Vice-President), who opened the discussion, said the author had referred to the large proportion of Imperial trade which now passed through the port, and gave percentages; but percentages were sometimes deceptive, and it would be interesting to know whether there had been an absolute gross growth of the trade with the Dominions or whether the increased percentage was due to a reduced trade with foreign countries. A good deal had been said from time to time about the falling off in the trade of the country, and he would be glad to learn whether the author's experience justified the pessimism sometimes expressed.

Presumably the reason why more was not said in the paper about the coasting trade was that, as the author had stated, the greater part of the coasting trade was dealt with in the Southampton Harbour Board's portion of the port, and not in the railway company's portion; but when one saw the statistics of the trade which was rail-borne from Southampton to other ports in this country it made one wonder a little. While it was the obvious business of the railway company to secure all the traffic that it could, it was felt by many people that the coastwise traffic was suffering from competition, and that it was not for the good of the State that it should all be allowed to be drawn away to inland transport. He inquired, therefore, whether anything could be done to help the coastwise traffic.

The author had been careful not to mention the Southern Railway, but he had referred to the former London and South Western Railway and to the fact that it took over the docks of the dock company. It was to that marriage that all the subsequent success had been due. The author would command general sympathy when he pointed out that just when the Southern Railway was committed to spend a great deal of capital on development, the Government decided to spend money on the development of less profitable spheres elsewhere.

If reference were made to the return on the capital invested in railway docks all over the country, it would be found that the Southern Railway showed a return on its dock investments of 2.75% in 1937, and 2.4 %in 1938. There were other docks in addition to Southampton which were involved in that figure but he was tempted to wonder whether the difference between what must be the cost to the company of the capital invested and that figure for the return on capital had fallen on the railway shareholders, just as the Government expenditure on schemes in Wales had fallen on the taxpayers, and whether the result was considered quite satisfactory by the shareholders.

Mr. J. G. Merriweather (former Member of Council) said the directors and management of the Southern Railway were to be congratulated on their enterprise, and in that connection a special tribute was due to Mr. Szlumper, the President of the Institute. He (the speaker) did not think that any port official had exercised more influence on port development than had Mr. Szlumper on the development of the Port of Southampton.

The author had referred to a depth of 45-ft., and it would be interesting to learn what was the dredging cost involved in maintaining that depth. The dock owners were fortunate that nature had provided conditions which permitted them to operate without dock gates, which in many docks were an expensive bugbear. Perhaps the author would say what was involved in the maintenance of the Port of Southampton, apart from the dredging.

Sir Sam Fay (Past President) said that one of the advantages or disadvantages of arriving at middle age, as he had done, was that he was able to speak from personal knowledge about history. He had been born five miles from Southampton, and sixty-five years ago he found himself wagging a telegraph needle in the South Western Railway offices at Southampton, so that he could look back well into the past. He did not go back quite so far as Canute, who had his feet wetted when he told the tide to keep away, but he himself had seen the tide kept away by the dock company, and subsequently by the London and South Western and Southern Railways, by the building of their fine system of docks. The film which had been shown gave an idea of what could be done in a comparatively few years, given enthusiasm, enterprise, and money, which the railway company, with the assistance of the local authorities, had been able to provide.

Mr. T. A. Bushell (Associate Member) mentioned that he had had occasion recently to do a good deal of historical research, and he came across some information concerning the Port of Southampton a hundred years ago. At that time it was not unusual for ships to go aground in the fairway when drawing only 20-ft., although to-day, as stated in the paper, there was a depth of 45-ft. at L.W.S.T. An enormous amount of work had obviously been required to make that possible, in view of the natural conditions which formerly prevailed. In those early days there were no facilities whatever for repairs, either to engines or to hulls, and it was usual to go to Portsmouth for the purpose; but the mercantile marine did not always agree, apparently, with H.M. Navy at that time, and frequently when a merchant vessel was about to be dry-docked, one of H.M. Captains would come rushing in and the operation had to be postponed for a few days, because preference had to be given to naval vessels. That did not assist commerce and shipping, and afterwards it became customary for a time to go as far as Northfleet.

Another point of interest was a report* by John Smeaton, the famous dock engineer, on the Port of Southampton, made in 1840, at the request of the old Royal Mail Company when they were discussing whether they should choose Southampton as their home port or go to Plymouth or somewhere else. The report referred to the natural advantages of Southampton and the concluding paragraph read:—

" I therefore consider that the situation of the proposed docks at Southampton affords an accommodation for your steam vessels which cannot be exceeded in England, and, as there exists no difficulty in the construction of the tide basin and docks, I consider that when the works are advanced, Southampton as a steamboat station will be unrivalled in England."

Mr. O. C. Power (a Vice-President) expressed the hope that he might receive from the author an answer to a question to which he had never yet had a satisfactory reply. This country allowed Dutch, German, Japanese and other foreign vessels to call at Southampton and other ports and pick up British passengers. Whenever he travelled on one of those foreign vessels he always felt a little guilty, because he was not satisfied that the British shipping companies obtained a square deal in the foreign ports at which they called.

Mr. W. H. Gaunt, C.B.E. (former Vice-President) asked whether the author could give further details regardng the employment of labour in stevedoring and generally carrying out the duties of unloading. Was that done by labour employed direct by the Southern Railway, or was it done by firms of agents? From time to time difficulties arose at other ports with regard to the admission of both passenger and goods road vehicles. Was Southampton perfectly free in that respect? Could one deliver or collect by road both passengers and goods, or was there some method which the railway company might consider fair to itself which put the matter on a different basis?

Mr. H. Hopperton (Member) [*Communicated*]:—Harbour managements would naturally desire to know what the capital expenditure was and whether a return on that capital was being earned by the harbour as apart from the indirect benefit to the railway.

In research into the principles of charging on tonnage, I found that Southampton was one of the few British ports which took into account the length of time vessels occupied berthage, in distinction to the general practice of charging dues which, after all, is rental, whether the vessels lay in a dock berth one day or 30 days.

The work at Southampton is an example of what is not generally recognised, that shipping, no matter how fast, is useless without a terminus. The growth of Southampton passenger trade also illustrates the fact that no matter what facilities dock

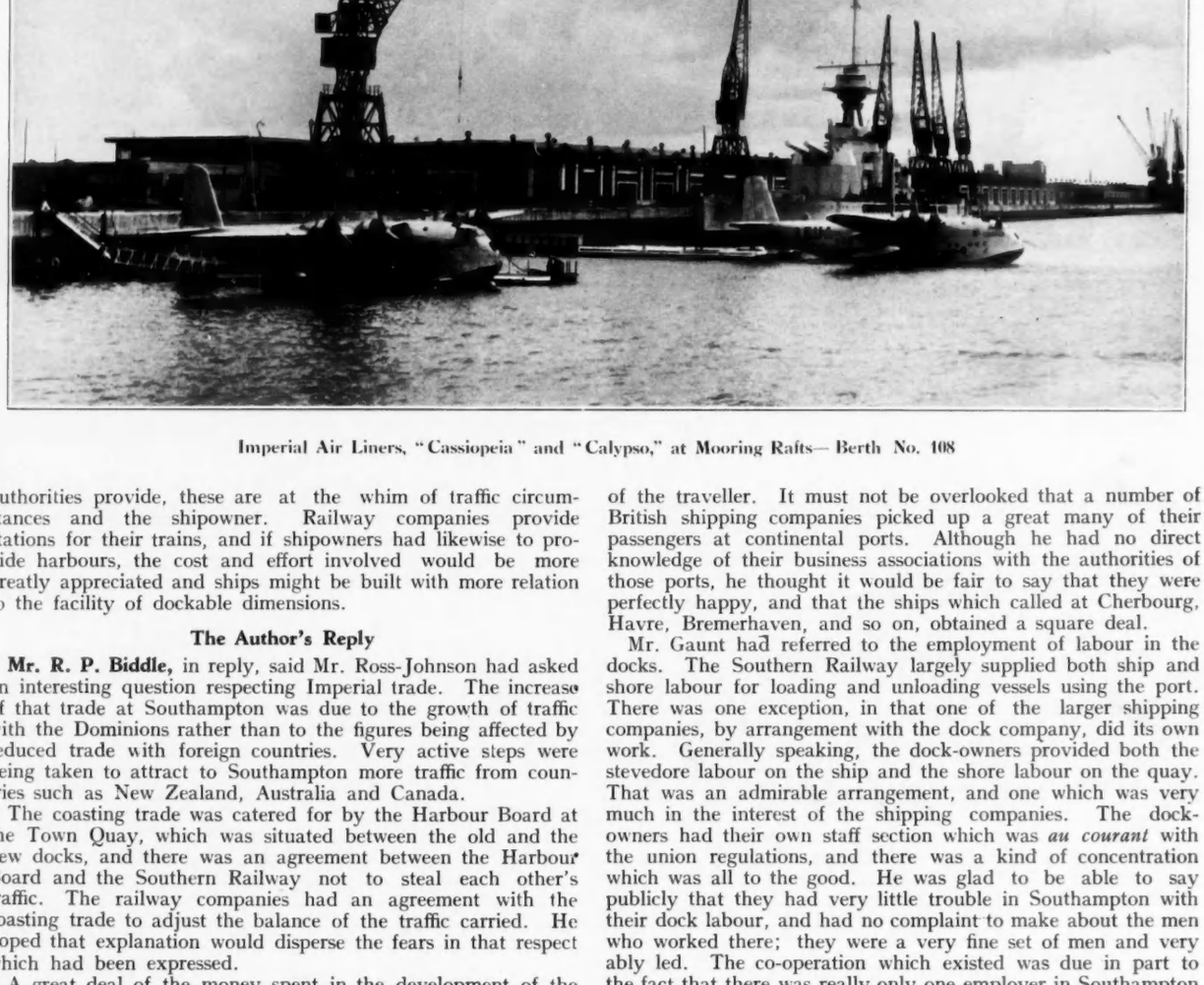
*The text of this report is in the library of the Institute of Transport.

Port of Southampton

Passenger Disembarkation at Docks Extension

Inspection of Passengers' Baggage by H.M. Customs in No. 43 Shed

Port of Southampton—continued



Imperial Air Liners, "Cassiopeia" and "Calypso," at Mooring Rafts—Berth No. 108

authorities provide, these are at the whim of traffic circumstances and the shipowner. Railway companies provide stations for their trains, and if shipowners had likewise to provide harbours, the cost and effort involved would be more greatly appreciated and ships might be built with more relation to the facility of dockable dimensions.

The Author's Reply

Mr. R. P. Biddle, in reply, said Mr. Ross-Johnson had asked an interesting question respecting Imperial trade. The increase of that trade at Southampton was due to the growth of traffic with the Dominions rather than to the figures being affected by reduced trade with foreign countries. Very active steps were being taken to attract to Southampton more traffic from countries such as New Zealand, Australia and Canada.

The coasting trade was catered for by the Harbour Board at the Town Quay, which was situated between the old and the new docks, and there was an agreement between the Harbour Board and the Southern Railway not to steal each other's traffic. The railway companies had an agreement with the coasting trade to adjust the balance of the traffic carried. He hoped that explanation would disperse the fears in that respect which had been expressed.

A great deal of the money spent in the development of the new docks had hardly yet commenced to fructify, although it was hoped that that would soon happen. Last year moreover, was not a very good one, owing to the depressing state of affairs generally throughout the world.

The Southampton Docks, both old and new, were self-contained in every respect. The owners constructed and maintained their own roads and had their own fire brigade, police, etc. Although the largest ratepayers in Southampton, they maintained all their ordinary services in the docks. The maintenance dredging was a serious item, and the obligation for dredging was to a distance of 600-ft. from each of the quays. The balance,—i.e., the fairway—was dealt with by the Harbour Board, who collected dues for their work. The other maintenance expenses included warehouses and buildings, dock gates, cranes, permanent way and electric plant.

He was glad Sir Sam Fay had been good enough to speak about the docks, because there was no one present who had had a longer experience of Southampton. By their work in connection with the docks, the Southern Railway had increased the size of England by something like 500 acres.

Mr. Bushell had referred to repair facilities. With the growth of the docks there had been an extension of the facilities for repairing ships; shipbuilding firms had set up industries, factories and workshops at Southampton to carry out the ordinary maintenance and running repairs of the liners using the port, and they arranged the dry dockings and all the usual work which was done when a vessel went into dry dock.

Mr. Power had referred to foreign shipping calling at Southampton to pick up passengers, and had asked whether the British companies were getting a square deal abroad. He would reassure Mr. Power on that point; he thought that the British companies were most definitely getting a square deal. He hoped that the day was far distant when there would be any kind of flag discrimination in travel other than of the individual taste of the traveller. It must not be overlooked that a number of British shipping companies picked up a great many of their passengers at continental ports. Although he had no direct knowledge of their business associations with the authorities of those ports, he thought it would be fair to say that they were perfectly happy, and that the ships which called at Cherbourg, Havre, Bremerhaven, and so on, obtained a square deal.

Mr. Gaunt had referred to the employment of labour in the docks. The Southern Railway largely supplied both ship and shore labour for loading and unloading vessels using the port. There was one exception, in that one of the larger shipping companies, by arrangement with the dock company, did its own work. Generally speaking, the dock-owners provided both the stevedore labour on the ship and the shore labour on the quay. That was an admirable arrangement, and one which was very much in the interest of the shipping companies. The dock-owners had their own staff section which was *au courant* with the union regulations, and there was a kind of concentration which was all to the good. He was glad to be able to say publicly that they had very little trouble in Southampton with their dock labour, and had no complaint to make about the men who worked there; they were a very fine set of men and very ably led. The co-operation which existed was due in part to the fact that there was really only one employer in Southampton who was responsible for both ship and shore. The Southampton Dock Authorities were perfectly impartial and beyond suspicion; and no discrimination whatever was practised between road and rail. There were hundreds of fruit merchants who used the Port of Southampton, and many of them employed road transport; but he did not think that any one of them would complain of the dock authorities being biased and not giving them just as good service as if they sent their goods by rail.

He thought that it would be agreed that the development of the docks was a lasting monument to the present President of the Institute, the General Manager of the Southern Railway. When Mr. Szlumper was Docks and Marine Manager, he helped to lay the foundation of a great development, and to-day those of us who are at Southampton are endeavouring to raise a superstructure worthy of those two great pioneers, Sir Herbert Walker and Mr. Szlumper.

Aberdeen Harbour Appointment.

The Aberdeen Harbour Board have recently appointed Mr. John Anderson as senior engineering assistant to the Harbour Engineer. Mr. Anderson was previously in the service of the Port of London Authority. He is a native of Aberdeen and received his early training at that Port.

Lord Mayoralty for Port Authority Chairman.

Alderman A. W. S. Burgess, chairman of the Port of Bristol Authority, has been unanimously recommended to the council by the Bristol Lord Mayor and Sheriff's Committee as Lord Mayor for the ensuing year. He entered the City Council in 1919 as a Labour representative, since when his municipal activities have continued without a break. He has been a member of the Docks Committee for some years.

Cardiff West Dock Centenary

An Interesting Ceremony

On September 20th, a simple and unpretentious ceremony marked the celebration of the centenary of the first dock constructed at the Port of Cardiff. On one of the walls of the Great Western Railway Company's offices between the West and East Dock Basins, the Lord Mayor of Cardiff (Alderman W. G. Howell) unveiled a plaque commemorating the opening in October, 1839, of the West Dock under the inspiration and direction of the second Marquis of Bute.

Photograph by courtesy of "Western Mail and South Wales News."

The Lord Mayor of Cardiff (Alderman W. G. Howell, J.P.), speaking at the ceremony on Wednesday, September 21st, 1939, at which he unveiled a plaque commemorating the centenary of the West Bute Dock, Cardiff.

It had been intended to mark the occasion by an elaborate civic programme, but under the stress of war time conditions, this became impracticable and the idea had to be abandoned. The ceremony, however, did not lose its significance by the absence of ostentation and display.

The Lord Mayor was accompanied by Lord Glanely, Sir Henry Mather-Jackson, Bt., Sir William James Thomas, Bt. (directors of the Great Western Railway Company), the Mayor of Newport (Alderman J. R. Wardell), Mr. George Williams (chairman of the Centenary Committee), and Mr. W. J. Thomas (Chief Docks Manager).

Sir Henry Mather-Jackson, chairman of the Docks Committee of the Great Western Railway Company, welcomed the Lord Mayor. He referred to the development of the great undertaking during the past 100 years. The original West Bute Dock opened in 1839 had a water area of 20 acres, he said. To-day the five docks had a water coverage of 160 acres. The expansion was due to the foresight and courage of the founders, and also of the pioneers of the South Wales coalfield. Later the Great Western Railway Company had spent a considerable sum of money to bring the docks up to a high standard of efficiency. Indeed, they could claim to-day that Cardiff docks compared favourably with any ocean-going docks in the United Kingdom, and they looked forward to an even greater future.

Before unveiling the plaque the Lord Mayor recalled the day 100 years ago when the first dock was opened. The town's population was only 10,000, and the main occupation was agriculture. It was recorded that in 1786 the Customs officers of Cardiff reported that no coal would ever be exported from the port because it would be too expensive to bring it down from the internal parts of the county.

Then in 1790 the ironmasters, who had come from other parts of the country, established themselves in South Wales and began the construction of the Glamorganshire canal, which was opened in 1798. The canal, which extended from Merthyr to the sea-lock, had an immediate effect on the trade of Cardiff, for, by 1838, the year before the opening of the West Bute Dock, the value of foreign shipments amounted to £362,000, carried in 292 vessels, while in the coasting trade 2,449 vessels were employed in carrying 123,614 tons of goods.

The limited capacity of the canal prevented any extensive shipment of coal and iron and the second Marquis of Bute conceived the idea of making a dock at Cardiff at a cost to himself of £350,000.

Notwithstanding the opening of the dock, trade remained stationary for about three years owing to the lack of transport facilities between the docks and the surrounding districts. This difficulty was eventually overcome by the construction of the Taff Vale Railway from Cardiff to Merthyr, which was opened in 1841. A few years later what was called the South Wales Railway was constructed from Gloucester to Milford.

Thus within 12 years of the opening of the West Dock the shipments of coal and iron from Cardiff reached over 1,000,000 tons. Yet in the first year of the dock's existence the trade amounted to only 8,282 tons.

The second Marquis of Bute could, with propriety, be called the maker of modern Cardiff because, as a result of his foresight, a small town of 10,000 inhabitants became a city of 227,000 people, and the exports and imports of the port increased from 8,282 tons to 13,676,941 tons, which were the figures in the record year of 1913.

They should not forget, continued the Lord Mayor, the wisdom and prevision of the successors of the second marquis, including the present marquis, who worthily carried on the traditions of their ancestor.

The Lord Mayor also paid tribute to the Great Western Railway Company in bringing the docks up to their present state of efficiency and making them the most modern in the world.

"There is one other word," he added, "that should be said at a time like this. Standing here as we do looking at the shipping in and about the docks, we feel we must express our gratitude to the men who go down to the sea in ships, who sail from this and other ports to their appointed destinations without regard to their own safety to bring to our shores the commodities necessary for our existence. May they be protected and sustained during these days of strain and stress in their gallant and patriotic mission."

Mr. George Williams, proposing thanks to the Lord Mayor, said he would like to thank, on behalf of the Cardiff City Council, all those organisations and individuals who had worked so hard to prepare the original celebrations which were to take the form of a civic week.

When war broke out they felt they could not proceed with the programme, but that day's limited ceremony was not without its purpose. He suggested that they should all pledge themselves to prepare for the peace. They did not want the depression in South Wales which followed the last war, and now was the time to start with their schemes of reorganisation.

Mr. W. J. Thomas seconded.

The ceremony, which occupied only half-an-hour, closed with the singing of the National Anthem.

The Evolution of Dredgers

By J. A. S. ROLFE, M.Inst.C.E., A.M.I.Mech.E.

Primitive Efforts

WHEN man first sat astride a log and launched himself on the waters, he bequeathed to posterity a problem to which s.s "Queen Elizabeth" and the great docks and harbours of the world are as yet an incomplete solution. The increasing size of ships has made a steady demand on the Civil Engineer throughout the ages for an equal increase in the depth of water available in harbours and docks. Unfortunately, we have no records of the manner in which our predecessor met this demand prior to the seventeenth century, but it is quite safe to assume that the builders of the ancient harbour of Crete, of Sidon and of Rome must have studied the interesting problems that dredging presents and have devised some method of surmounting them.

The "Spoon and Bag"

It is probable that primitive man astride his log found that by dragging away the bed of the river near the banks he could land without the necessity of wading through shallow water and in making this basin for his craft he laid the foundation of harbour engineering. In stirring up the mud, he no doubt found that a pole with a flat piece of wood fastened across its extremity served as an efficient mud rake and thus was the first "dredger" born, and so useful was this tool that it has survived to the present day and still can be seen in use in tidal creeks. The logical development of this tool was the substitution of a bag for the head of the rake, whereby the operator could deposit the dredged material ashore or dispose of it by some other means. This developed into the "spoon and bag" dredger and is another example of a primitive tool which is still in use in the present time in shallow waterways. In course of time, the "spoon and bag" dredger increased in size in order to meet the demand for deeper water, and Edward Cresy in his Encyclopaedia of Civil Engineering, compiled in 1847, describes a machine of this type which was used in Venice. He says, "the machine at Venice probably first suggested our modern dredger; it consisted of an oblong pontoon, covered in, on the deck of which the machine was worked; its length was nearly 50-ft., and its breadth a little less than half; below the deck the space was used by the workmen as a lodging place. The Mechanism attached was a large wooden beam, which moved on a pivot in its centre; this beam was formed of tapering pieces, about 50-ft. in length, and together 3-ft. in thickness; there were five rows, bound and hooped round with iron; this strongly constructed beam was furnished at one end with two nuts, into which worked a perpendicular screw of beech, upwards of 30-ft. in height, and about 14 or 15-in. in diameter. This screw worked in a socket or plate, fixed at the bottom of the pontoon, and this being provided with a windlass below the deck, the screw was made to elevate or depress the huge wooden beam, which usually lay in a horizontal position.

At the outer end of the beam, a large iron spoon was worked, which had by means of pulleys an alternate motion of rotation given to it by two vertical cylinders placed within the pontoon; the iron spoons were opened and shut by ropes and pulleys, and the dredging action was commenced by slightly depressing, then raising the beam; by the first movement the cover was moved, by the second the spoon was opened; after it had filled, it was again covered and lifted out of the water; such a heavy complicated apparatus consumed much labour, and required to be moored very strongly to the place where it was worked, and the manoeuvring of the perpendicular screw, which gave movement to the weighty timber beam, was attended with painful and laborious exertions.

Eight men were required to work it, and they generally raised in a day about sixty cube yards from a depth which did not exceed 14 or 15-ft.; when a greater number of men were employed, the quantity raised was proportionately greater, and twelve, which were as many as well could work at one time, have been known to lift more than a hundred cube yards. The spoon or drag contained two and a half cubic yards, and the mean time for lifting it was a quarter of an hour; thus with forty extractions in a day considerable space was cleared: such a machine was said to have cost upwards of 800 pounds."

The Dipper

It is not known exactly when the "bag and spoon" developed into the dipper dredger as we know it to-day, but we do know that a dredger comparable in operation with the modern "dipper" was in use in Toulon Harbour in the Eighteenth Century. This is very fully described by "Belidor" in his "Architecture Hydraulique," published in 1770, and is shown in Fig. 1, which is a copy of a print from this work. The bucket shown has a capacity of about 50 cubic feet and the dredging depth is about 16-ft.

The introduction of steam permitted an increase in both the size and output of dredgers and in 1796 a dipper was at work in Sunderland Harbour, the motive power being a steam engine designed by Boulton and Watt of Soho, Birmingham. This is described by Messrs. James Watt and Company in a letter to J. J. Webster, Esq., M.Inst.C.E., in connection with his paper on "Dredging Appliances," read before the Institution of Civil Engineers in 1886 (Vol. LXXXIX—1886-7, Part III, Proc.Inst.-

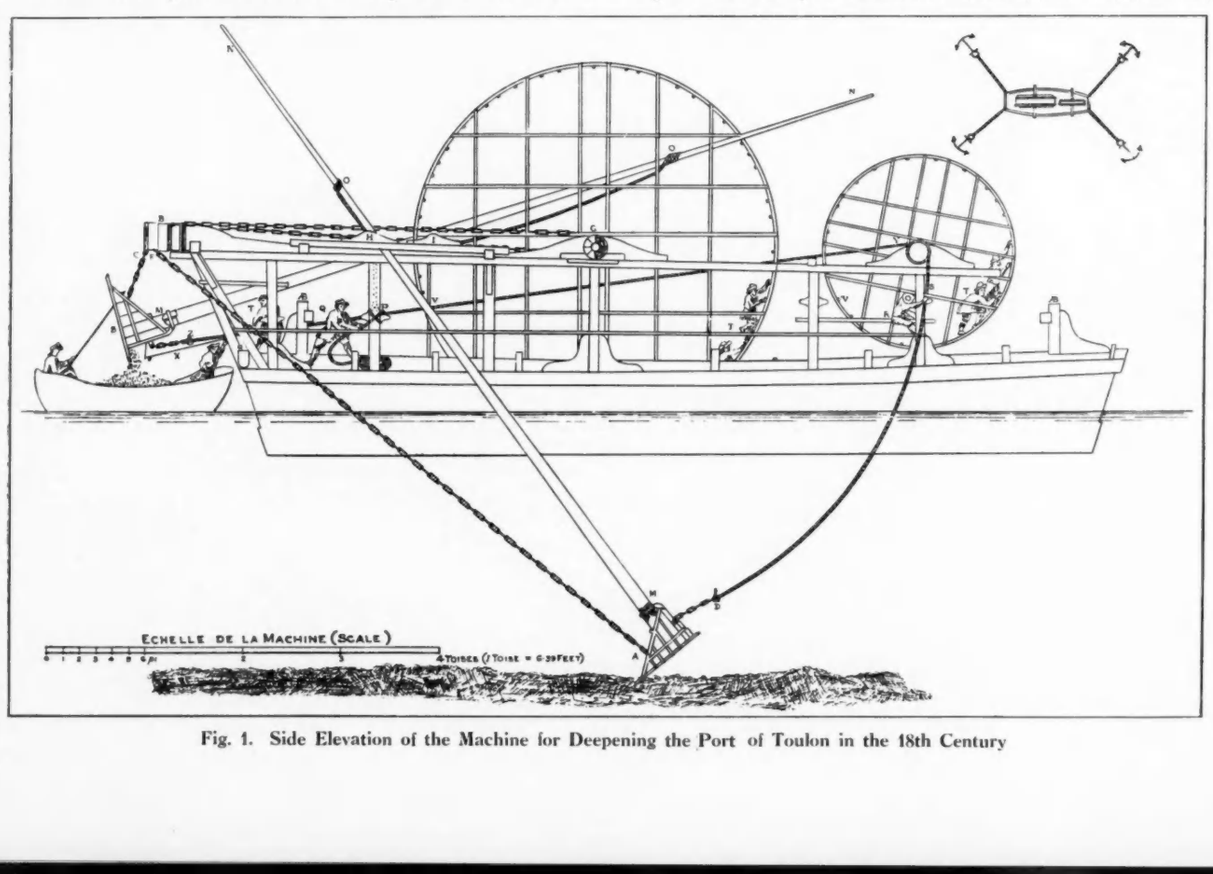


Fig. 1. Side Elevation of the Machine for Deepening the Port of Toulon in the 18th Century

The Evolution of Dredgers—continued

C.E.). In this letter it is stated that "our firm supplied, in 1796, a beam-engine, having a steam cylinder, 12⅛-in. in diameter, and 3-ft. stroke, for working the spoons, which were previously worked by men, for cleansing Sunderland Harbour. These spoons were in the form of a truncated cone, the narrow end of which was closed; and to the other, or open end, was fixed a spade bit. They were made of a hide of leather, having an iron rim. The engine was to be fixed in a boat, 20 or 22-ft. wide by 60-ft. long."

[By Courtesy of Messrs. Lobnitz & Co., Ltd.].
Modern Dipper Dredger

The Bucket Dredger

The bucket dredger would seem to be a logical development of the "bag and spoon," improvements in prime movers allowing a succession of bags to be raised, although some early bucket dredgers were operated by manual or animal power. As with other types of dredgers, the date of the first bucket is very uncertain. Prelini gives the date as 1591, the inventor being Veranteus.

A later reference is that in "Shipbuilding from its beginning" by Von Konijnenburg, issued by the Permanent International Association of Congresses of Navigation in Brussels. In this article the date of 1632 is given as being the year in which one Jan Jantz Nieng, a citizen of Hoorn (Holland), invented the "diepmolens." This dredger was called the "Dieplust" and is described as follows:—

"The Dieplust" extracted the mud by means of a trough with low straight sides, lined at its lower end with iron. When the boat was moved, by means of a cable attached to an anchor, the lower end of the trough entered into the mud as far as it could. The ladder of the dredge was suspended inside of the trough and to its endless chain were fastened pieces of plank of about the same width as that of the trough. These pieces of plank tumbling around a hexagonal or octagonal drum at the lower end worked down into the mud of which they brought up a certain quantity and discharged it through a hole at the top of the trough.

There was no question of buckets to bring up the dredged materials, these having only made their appearance with steam dredgers.

The trough, with the ladder, could be lowered or raised by means of a windlass; it passed through an opening which was not in the axis of the board. In the larger half of the vessel was placed the shaft, which, by means of gearings, transmitted to the ladder the movement produced by the horses. These gearings were similar to those of the old wind mills. A horse power and a stable were constructed on the deck of the boat."

Doubt, however, has been expressed regarding the date of this invention, as in 1628 the following entry appears in the Resolutie Boek van de Staten van Vlaanderen of 1628—1830, Fo. 16 (Archives of the State at Ghent, No. 553):—

> " (1) By act of May 22, 1628, it is ordered that there be paid to Adam Clippens Engineer who built the mud mill, a sum of 100 florins for the bid which he presented."

Whether Clippens' dredger is similar to that of Nieng or whether the earlier date is incorrect is not known. It is certain, however, that the first mechanical dredger of this type was in use in the early part of the 17th Century.

Cresy describes a machine called a " Chapelet," which was undoubtedly a bucket dredger, but no date is given. His description is as follows:—

> " The CHAPELET was composed of three rollers, two of which touched the ground, and the other was placed above a timber scaffold, on which the soil dredged was to be raised, round these rollers worked an endless chain formed of large links, alternately flat and square; to this was attached four or more scoops or scuttles, placed at regular distances, made of sheet-iron; these were pierced with holes, and provided with a strong, projecting beak, which not only entered, but cut its way into the mud or earth below. The cylinders were armed with iron spikes which entered the square links of the chain, and turned round on pivots, working within a frame made for the purpose, of timbers sufficiently strong to retain them, and put together so that they could be raised or lowered as the depth to be dredged required. The whole was put in motion by a wheel and winch, placed parallel to the cylinders, and by which they were turned; the axis of the winch working in a lantern turned the cylinders, and they in their motion brought up the loaded scuttles made fast to the endless chain; when either of the scuttles had arrived above the upper cylinders, it became included, and deposited its contents, which were immediately drawn away by a vessel or trough, and in this manner the scuttles were kept in motion and discharged. When the depth was greater or less, the machine was made to accommodate itself by the introduction or taking away of some of the links, and mounting higher the two lower cylinders. The winches being turned, moved the lantern fixed to their common axis; this engaging in a toothed wheel fixed to the upper cylinder, in turning drew the chain and scuttle attached to it, and also turning round, occasioned the descending scuttle to enter the ground, and to elevate the loaded one to the top of the machine, where it was thrown over, and deposited its contents upon a hinged trough, attended by a workman, who directed its further course."

During the reign of Charles I (1625-1649) a dredger was constructed by an inventor named Balme which consisted of a vertical wheel on which were six buckets, the wheel being supported between two boats. This dredger, which is described by Knight, was used for raising mud in the Fen district of Lincolnshire.

In 1680, a dredger was constructed by a Dutch engineer, Cornelius Meyer, for use in the canals of Holland. This dredger is referred to by both Cresy and Knight and from the description given by the latter this dredger was similar to that invented by either Jan Jantz Nieng or Clippens. Prelini gives the date of this dredger as 1685.

In 1718 a bucket dredger was designed and patented by Savory and in 1747 a dredger of this type was in use in England. In 1781 a bucket dredger was constructed in England, one horse being used as the driving force. Prelini makes reference to these dredgers but does not give any description of them.

Application of Mechanical Power

The first power driven bucket dredger in England appears to have been used at Hull early in the nineteenth century. Cresy gives a very clear account of this dredger. No apology is made for again quoting at length from his article as it is an interesting description of an early bucket dredger.

> " The machine employed by the Hull Dock Company in 1802 had eleven wooden scuttles working on a ladder that passed over rollers, the motion given by a horse-wheel; those now used in the harbours and navigable rivers, worked by powerful steam engines, have a series of iron or copper scuttles attached to a chain, which like a chapelet works round a beam elevated at the side of the vessel, and brings up large quantities of ballast at each dip. The fly-wheel of the dredging machine is turned by a large spur-wheel fixed on the shaft, acting on a pinion

The Evolution of Dredgers—continued

[By Courtesy of Messrs. Ferguson Bros., Ltd.].
Double Side Ladder Bucket Dredger "Bulldog" at Port of Calcutta—Capacity 1,200 tons per hour

on the axis of the fly-wheel, to give it a greater velocity than the crank, by which means a smaller fly-wheel is sufficient to regulate the motion of the engine. The motion is conveyed from the steam engine to the chain barrels by the inclined shaft, shown in the section; at the lower end is a bevelled wheel, which receives its motion from another fixed on the main shaft of the engine. At the upper end also of the inclined shaft is another bevelled wheel, working in another fixed to the shaft, and situated in a line with the centre of the two chain barrels; at the two extremities of this shaft are two wheels, which communicate power to the chain barrels, and bring up the ballast; an engine of 16 horse-power, dredging on a moderate depth, will raise 35 tons in an hour, and consume about 343 pounds of Newcastle coal in that time. The upper roller is a square barrel, as is that at the lower end, and around them passes the double endless chain, each alternate link of which carries a bucket; these are pierced full of holes, to allow the water to drain out as the sand or gravel it brought up. The mouths have a semi-circular form, to prevent their sticking fast during the operation."

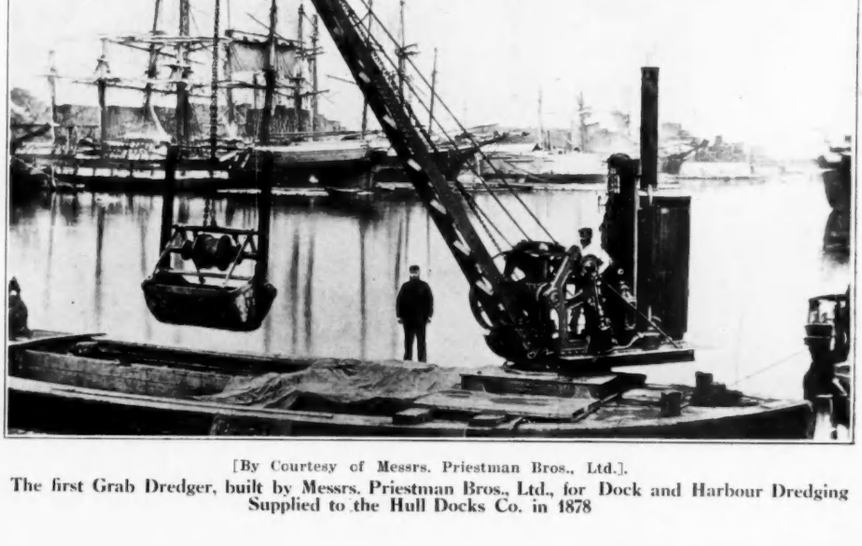
A power driven bucket dredger appears to have been worked on the River Thames in 1804 by Mr. John Hughes, who raised, in one day, 2,000 tons of spoil from a depth of 30-ft. A complete description of this dredger is not available, but we learn from Cresy that "it had 4 rollers, each of which had one spoon; the rollers were made to move at 10-ft. per minute, and each spoon could bring up 15 cwt. at a time." It was apparently driven by a 30 horse-power engine. Knight in his Dictionary of Mechanics also refers to this dredger and gives its cost as £8,000.

A steam-driven bucket appears to have been used in Sunderland Harbour in 1800 or thereabouts. In the paper by Webster already referred to, he quotes a reference made in the local press in 1833, reading as follows:—"October, 1811. A very curious machine, for cleansing and deepening Sunderland Harbour, was set to work. A steam-engine of great power was erected upon a floating barge, which continually drove round a number of iron buckets fastened to a chain, which filled themselves with sand and gravel at the bottom of the harbour, and successively emptied themselves at the top of the shaft into a spout ready to receive them. This machine could lift 55 tons of ballast in thirty-five minutes."

From 1800 onwards, the bucket dredger develops its present form, growing more powerful to cope with the increasing demands for deeper water. Improvements in material and manufacture also assisted in this development until from the midget used in Sunderland, mentioned by Webster, whose buckets in all probability did not have a capacity of 10 cubic feet or the dredger an output of 45 tons per hour, we arrive at the present day monsters with 54 cubic feet buckets and an hourly output of 2,000 tons.

The Grab

The "grab" dredger is a further illustration of the development of a very simple manual operation, that of excavating soft materials with two hands, the fingers acting as "tines" and the ball of the palms pressed together to form the hinge. At what period in our history this action was first mechanised it is not known. It is claimed that it is a recent development. This, however, it is difficult to agree to. Mr. W. J. E. Binnie, M.A., M.Inst.C.E., in his Presidential address to the Institution of Civil Engineers in November, 1938, refers to the siege of Syracuse where Archimedes in defending that city against Marcellus mounted "Machines, which must have resembled cranes with a balanced jib, were built behind the walls out of view of the attackers, and when the galleys had reached the walls, the jib was swung outwards by means of chains and pulleys. Over the pulley of the jib ran a chain to the end of which heavy weights were attached, which were dropped on to the galleys, causing great damage and confusion. The cranes



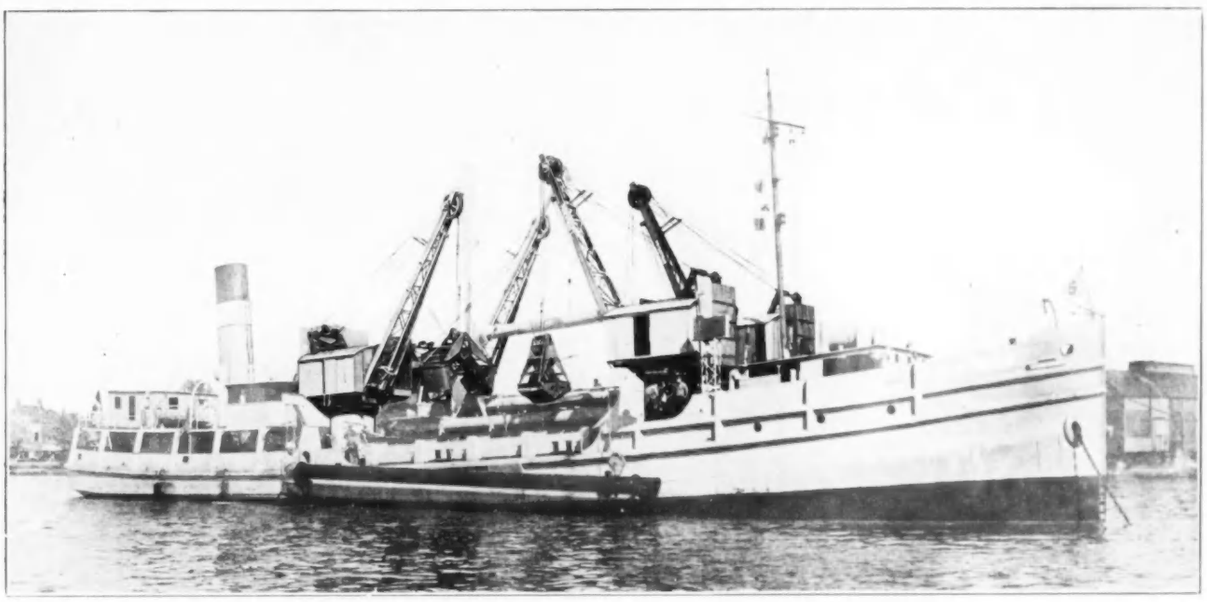
[By Courtesy of Messrs. Priestman Bros., Ltd.].
The first Grab Dredger, built by Messrs. Priestman Bros., Ltd., for Dock and Harbour Dredging Supplied to the Hull Docks Co. in 1878

The Evolution of Dredgers—continued

were also equipped with powerful claws or grabs which seized the prows of the galleys and lifted them right out of the water, the vessels becoming full of water when dropped back again and many being capsized. The grabs must have been very powerful when the size of a Roman galley is considered, and one would be inclined to treat the story as a fable if confirmation were not forthcoming from Marcellus himself, who wrote that 'his vessels were treated as buckets to draw water.' " This must be the very earliest known reference to a grab machine employing the principles of the modern dredging grab. Dekker in his "Dredging and Dredging Appliances" gives an illustration of a grab dredger which is dated 1617. This is followed by a reference by Sir Benjamin Baker in his discussion on a paper on "Plant for Harbour and Sea Works," read before the Institution of Civil Engineers by Pitt, to the grab being an invention of one, M. Gouffe, which is described in the Proceedings of the Academy of Sciences in 1703.

Knight in his Dictionary of Mechanics, published about 1873, already referred to, gives a sketch of a different type of suction dredger in which the suction tube is led to the mud from an air-tight tank from which the air was exhausted by a suitable pump. The air being exhausted from the tank, it automatically filled with mud after which the dredger proceeded to the dumping ground and discharged the load. Unfortunately he does not give the inventor's name or give the date of the invention, nor does he state if the dredger was ever constructed.

Webster, in his paper already referred to, gives a description of the Woodford Sand Pump which appears to have been a suction dredger. In this dredger the centrifugal pump was lowered at the end of the suction pipe into the mud. The impeller which was in a horizontal position, was driven from the deck of the dredger by means of a vertical shaft. The date of this dredger is not given, although a modification of Woodford's machine was in use in Amsterdam in 1868, so that this dredger



[By Courtesy of Messrs. Priestman Bros., Ltd.].

Combined Grab and Suction Dredger "San Juan," equipped with four Priestman No. 60 size dredging cranes operating 60 cu. ft. capacity "Level-Cut" Grabs at 22-ft. radius. Capacity of hopper 1,000 tons. Approximate output 655 tons per hour

Prelini dates the first grab as 1773, its inventor being Fr. Dominico Ferra. Whatever the date of its first invention, the "grab" has altered very little in principle until quite recently. It has always consisted of a pair of scoops, in section resembling a quadrant of a circle, which are pivoted on a cross shaft at a point approximately to the radius of the scoops, the scoops when opening describing a circular path. The method of opening only varied. The grab of 1617 referred to by Dekker and that of Gouffe were definitely double chain grabs but we are uncertain as to how that used by Archimedes or invented by Ferra were operated. When this machine was first extensively used on dredging, the single chain control was favoured. This gave way at a later date on account of its uncertain action under water to the double chain control, which on account of its simplicity is still in use. The only departure from the orthodox grab is that of the "level cut" grab introduced by Messrs. Priestmans and brought to the notice of the general public by the makers of a well-known beverage. In this grab, the jaws move in a horizontal direction and not radial.

Suction Dredging

It can fairly be claimed that there is one type of dredging which man has invented and that is suction dredging. It is true that in nature the family of molluscs use the principles of suction dredging, but even they possess nothing similar to a centrifugal pump. The first suction dredger was designed, it is claimed, by Bazin, who in 1867 exhibited a model of this type of dredger in the Paris Exhibition. It was developed by the inventor for use in the Suez Canal. Bazin's dredger used a centrifugal pump to create a suction through a tube, one end of which was connected to the pump suction, the other end being dragged through the sand or mud by the dredger which in this type of dredging, is continually on the move. The suction end of the pipe had a slight bend so that the inlet was roughly parallel with the surface of the material to be dredged. The pump being set to work created a powerful suction which with the suction inlet of the tube buried in the material to be dredged, sucked the material up and discharged it into a hopper. In 1871 a similar dredger was used in the United States of America.

must have been invented about the same time as Bazin's machine. In principle, Bazin's dredger remained unaltered until about 1900, when Herr Otto Fruhling, a German engineer, invented a special type of head for use on the inlet end of the suction pipe. As has already been stated, the suction inlet was roughly parallel to the surface of the mud to be dredged, with the consequence that if the inlet was allowed to sink too deeply in the mud it choked, whereas, if it was kept near the surface, it sucked in excessive quantities of water. Fruhling, therefore, devised a head which had its inlet at roughly 90° to the surface of the mud and was connected to the suction tube by a special bend. The head was also provided with fixed cutters to break up hard materials. This type of head was lowered down until its inlet was sealed in the mud and it was kept in this position as the dredger moved forward. This improved head resulted in a great increase in the consistency of the mud raised, for whereas the early pattern head only raised only about 25 per cent. mud, the new head raised up to 80 per cent. mud.

Subsequently a new type of head was designed by Allen in America, which is also an improvement on the original head used by Bazin.

(To be continued).

Publications Received

Messrs. Robert Boby, Ltd., of Bury St. Edmunds, have issued a new 8 pp. Folder—M.H.45, which illustrates a number of recent installations of materials handling plant and steel and concrete structures.

We have received a copy of the first edition of a report on Port and Terminal Charges at United States Great Lakes Ports, issued by the Board of Engineers for Rivers and Harbours as No. 4 of the Miscellaneous Series. The volume gives information relative to the services and charges of the United States Government and local port authorities which are applicable to vessels, freight, and passengers at the principal United States Great Lakes Ports. The particulars will be revised annually so that information will be available as from 1st January each year.

Notes of the Month

Danish Port Development.

It is announced that important extension works, estimated to cost 4½ million kroner, are to be undertaken at the Port of Odense, Funen. A contribution of one-half the cost will be made by the Danish Government.

English Canals in Wartime.

In reply to a question in the House of Commons, the Minister of Transport stated that, to ensure the best use of canals during the war, a Canal (Defence) Advisory Committee had been constituted. This committee included representatives of the Canal Association and the National Association of Canal Carriers.

Novel Pier at Djibouti.

The ship " Fontainebleu " having stranded and become partly destroyed by fire at the Port of Djibouti in French Somaliland, attempts were made to remove her, without success, owing to her position and condition. It is now reported that the hulk has been encased in stone and concrete and converted into a pier to be used for mooring vessels.

Progress of New Capetown Harbour.

The formation of the new outer harbour at Capetown continues to make good progress. To date, it is reported that the outer breakwater is practically completed for its entire length of 7,000-ft., while over 2,000-ft. of quay wall is constructed and about one-third of the dredging and reclamation work done. Including the four berths recently brought into commission on the North side of the Basin, the berthing accommodation for ocean-going vessels has been increased from 11 to 17 ships.

Dredging of Clyde Channel.

At a recent meeting of the Clyde Lighthouses Trust held in Glasgow, a survey plan of the Clyde Channel was under consideration, showing certain patches of high ground which remain to be removed. The matter has assumed importance in view of the impending passage of the " Queen Elizabeth " to open waters. It was felt that some of these patches did not call for immediate dredging, and Messrs. John Brown and Co., Ltd., the builders of the " Queen Elizabeth," are to be invited to express their opinion.

Reconstruction Works at Rothesay.

The Rothesay Harbour Trust considered, at their last meeting, several tenders which had been received for the rebuilding of Rothesay Pier offices, waiting-rooms, etc., but deferred a decision to proceed with the work at the present time in view of the Government recommendation that no new works should be commenced. Work which has been in hand for some time on the extension of the pier structure will be continued to completion. It had been intended to have the new buildings available for use at the commencement of the Spring traffic in 1940.

Depth of Water at Honfleur.

The Monthly Circular for August of the Baltic and International Maritime Conference announces a decrease in the depth of water available at the Port of Honfleur in Northern France. Particularly is this the case during neap tides, when the available depth may be as much as 3-ft. less than the figure published in certain handbooks. It is understood, says the Circular, that there is a continual variation in the depth of water on the bar owing to the movement of sand banks, and, in the course of 24 hours, the depth may vary as much as 1-ft. at the entrance, which is very narrow. Dredging operations are stated to be in progress.

Re-organisation at the Port of Orleans.

A resolution recently passed by a New Orleans body indicates that there is dissatisfaction locally with the administration of the port, and an enquiry has been set on foot to determine " what factors, if any, are serving to retard the progress of the port." The enquiry will be conducted by Mr. Francis Williams, former member of the Louisiana Public Service Committee, on behalf of the Board of Port Commissioners. In a preliminary statement, Mr. Williams has pointed out that imports and exports at New Orleans during the five-month period ended 31st May, 1939, were 55 million dollars less than for the same period in 1938. The enquiry will seek to establish whether the operation of the New Orleans Public Belt Railroad is a help or a hindrance to the port; whether the Industrial Canal is an asset or a liability; to whom the business of the port has been lost, or whether lost by the nation as a whole, and to what extent, if any, the Federal Crop Loan policy has adversely affected the business of New Orleans and other ports.

American Association of Port Authorities.

The 28th Annual Convention of the American Association of Port Authorities will be held in Milwaukee, Wisconsin, from October 8th to 12th, under the presidency of Mr. George W. Osgood, of Tacoma, Washington.

Congestion at Copenhagen.

As a consequence of the outbreak of the war, the harbour of Copenhagen is reported to be " choked " with Danish and foreign ships. The loss due to the suspension of shipping movement is considerable.

Clyde Lighthouses Trust.

Mr. George F. Sloan, who has been chairman of the Clyde Lighthouses Trust for the past ten years, has resigned on grounds of health, and Mr. John C. Graham has been elected to succeed him. It was reported at the same meeting that the revenue of the Trust had shown a decline during the current year.

New Radio Beacon at Tynemouth.

A new radio beacon has been installed on the North Pier at Tynemouth. Normally, it has a range of 50 miles, but it is expected to be heard, under favourable conditions, at distances up to 200 miles. The wave length is 535 cycles per second. There is a fog-transmission signal, operating at 86 cycles per second every six minutes.

New Wharf at Rotterdam.

A new wharf and a cargo shed have recently been provided in the Waalhaven at Rotterdam for the reception of bonded and miscellaneous goods. The shed has an area of 2,000 sq. metres. There is quayage of 730 lin. ft., with a depth alongside of 27 to 28-ft. An equipment of four quay cranes and a floating crane is available for service.

Montreal Harbour Improvements.

Considerable activity in harbour constructional operations is reported from Montreal. Work costing over £100,000, is already in hand, and additional work, estimated at £60,000, is being undertaken. Altogether, all the work in hand in and around the harbour represents an outlay of over £200,000. The sheds for the Elder Dempster Lines, Ltd., and the Ocean Dominion Steamship Company, are being reconstructed.

Durban Harbour Development.

A report issued by a special Committee appointed by the Government of South Africa, puts forward a scheme for doubling the berthage accommodation in Durban Harbour. The Committee consisted of delegates from commercial and industrial interests, the Municipality, the Conference Lines, and the Railways and Harbours Administration. They recommended a plan for the reclamation of an extensive area of swamp land at the head of Durban Bay, with the construction of projecting jetties capable of providing accommodation for an additional twelve steamships. The cost is estimated to be at least four million pounds, including the canalisation of three rivers which flow into the Bay. When the scheme is completed, it is intended that the existing area of the port shall be used exclusively for the reception of perishable products, commercial orders and passenger traffic.

Passenger Port Regulations.

Under the Defence Regulations, Orders have been made by the Home Secretary prohibiting the landing or embarkation of British subjects, except at certain approved ports. The public are asked, in the national interest, to avoid as far as possible journeys, including sea travel, for which a permit is required.

The Orders apply to all passengers coming from or proceeding abroad, as well as to those travelling between Great Britain and Northern Ireland, Eire, Isle of Man and Channel Islands. The Orders do not apply to those making coastal journeys between one part of the mainland of Great Britain and another, or to islands which are part of Great Britain, e.g., Isle of Wight, Scilly Isles, Western Isles, etc.

The revised list of approved ports is as follows:—

London.—Tilbury Dock, Tilbury Landing-stage, West Street Pier, Gravesend.

Folkestone, Newhaven, Southampton, Falmouth, Bristol, Fishguard, Holyhead, Liverpool, Heysham, Belfast, Larne, Stranraer, Glasgow, Tyne ports, Hull.

Air Stations.—Belfast (Harbour), Bristol (Whitchurch), Liverpool (Speke), Pembroke Dock, Perth, Poole Harbour, Shoreham.

Investigation of the Outer Approach-Channels to the Port of Rangoon by means of a Tidal Model

By OSCAR ELSDEN, M.Sc., Assoc. M. Inst. C.E.

(Continued from page 327)

Some care was exercised in the choice of sand for the moulding of the bed of the model, the desiderata being based on the experiments made by Professor Gibson when selecting sand for use in the model of the Severn Estuary. Professor Gibson established that the size of sand for use in a river model should be about three-quarters the size of the actual sand in the river bed, the size of a sand-grain being taken as the mean of two of its axes† Samples of Rangoon sand were measured microscopically to find the mean size, and suitable commercial sands were selected by testing samples in the same manner. Two sands were chosen; the first, a silver sand from Cornwall, was used for moulding the more important areas of the model, and the second, a very much cheaper ferruginous sand from the Sheffield district, was used for the remainder. These sands had practically the same density as the Rangoon sand, that is, about 2.65.

To find means of tracing the movement of the sandy bed of the model, several samples of coloured sand were also examined, but none was found suitable. At the suggestion of Mr. H. J. Collins, M.C., M.Sc., M. Inst. C.E., some of the silver sand was pigmented with powder-colour and stone preservative. It was found that the process produced a fast colour unaffected by water; subsequent tests showed that neither the size nor the density of the sand grains was measurably affected by this process, so that sand coloured in this manner could fairly be used to indicate the travel of the uncoloured sand. Some very useful results were obtained in this way.

Before starting the experimental programme it was necessary to adjust the tide-engine to give a tidal wave of the correct form. The model tidal-wave could be measured on four permanent tide-gauges erected at points where such gauges were in actual fact maintained. The model-gauges were engraved on ivorine strips, and were divided into sixteenths of an inch, which in the model correspond to intervals of 1-ft. vertically. These gauges were mounted on screw rods carried by stiff brackets bolted to the concrete portions of the model. The screwed rods permitted adjustment of the gauges to show the correct readings when the water in the model was stationary and at a known level. The model-gauges were situated at:—

(a) Mengalun (mouth of the China Bakir River).
(b) Elephant Point.
(c) Brooking Street (at Rangoon itself).
(d) Twante (at the junction of the Twante Canal and the China Bakir River).

An additional gauge, having no counterpart in actual fact, was provided on the seaward edge of the model at a distance of about six miles from the main tide-plunger.

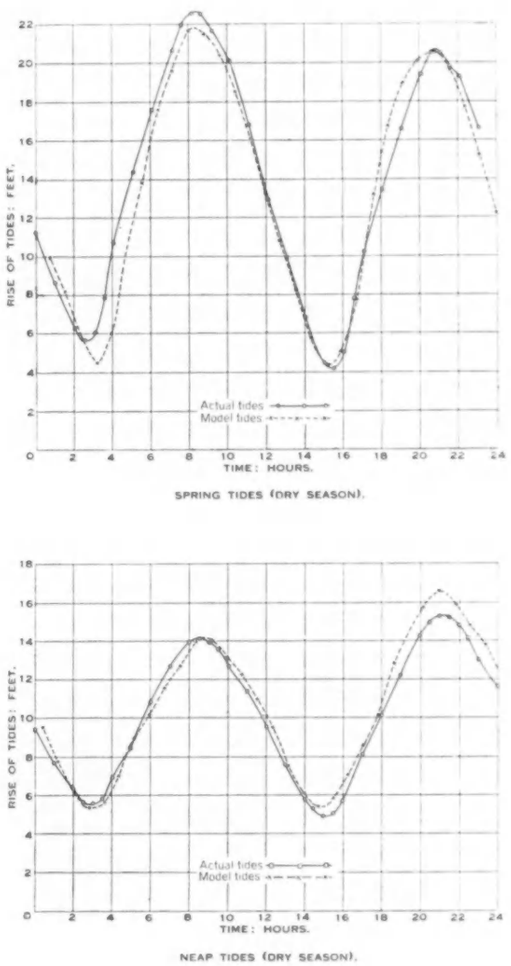
The Technical Officers of the Port had obtained height-time curves at these gauges. Simultaneous height-time curves were obtained under varying tidal and seasonal conditions at the first three stations, and gave the necessary information regarding the true shape of the tidal wave, the rate of its progress up the Gulf, and the deformations which appeared in the wave as it entered the shallower and more constricted waters of the Rangoon River. This information was supplemented by an extensive series of predictions made by the tidal-model staff from the published harmonic constants‡

After the model was completely moulded, similar height-time curves were obtained from the model-gauges. Readings were taken simultaneously at two gauges, each of which was watched by a separate observer, who noted the gauge reading every five seconds, as timed with a stop-watch by a third man. The method is laborious but reliable. The five-second intervals represented about 45 minutes on the model time-scale, and the readings obtained were plotted on tracing paper, to the same scale as the actual height-time curves. The observations were repeated for spring and for neap tides, under monsoon and dry-weather conditions, and the machinery was adjusted until the model tidal wave bore a reasonable resemblance to the real one. Figs. 8, Plate 1, shows a typical comparison between model and actual-time curves.

Trial Runs of the Model

The general programme divided the investigations into three stages. The first was a trial of the model to show that it would properly reproduce the known changes that had occurred over a given period. If this trial were successful, the second stage was to be the operation of the model, starting from present-day conditions, to find the regime which might result from the unchecked development of present tendencies. The final stage was the study in the model of any remedial measures suggested by the behaviour of the model, and the selection of the most suitable course of action.

FIGS. 8.



COMPARISON OF PRESENT-DAY TIDES AT ELEPHANT POINT, WITH TIDES GENERATED BY MODEL.

The first series of experiments was started as soon as all adjustments had been completed. The earliest available charts of sufficient accuracy and detail were those showing the surveys of 1875 and 1877, and the bed of the model was accordingly moulded to strawboard templets prepared from these charts. The model-rivers were adjusted to give average monsoon conditions, alternating with average dry-weather conditions, on the assumption that over so long a period as that contemplated for the trial runs, the final result is an average result. In a similar manner the tidal cycle that was reproduced in the model took no account of abnormal variations in the actual tides.

The operating routine of the model varied little throughout the whole course of the investigations. The few important

*Paper read before the Institution of Civil Engineers on 4th April, 1939, and reproduced from the Journal of the Institution by kind permission.

†A. H. Gibson, "Construction and Operation of a Tidal Model of the Severn Estuary." H.M. Stationery Office, London, 1933.

‡Tide Tables of the Indian Ocean. From Admiralty Tide Tables, 1938, Tidal Predictions. Part 1. Section B.—Foreign Waters (The World, except British Islands and North and West Coasts of Europe). Published by His Majesty's Stationery Office for the Hydrographic Department, Admiralty.

Port of Rangoon—continued

extensions and improvements in method will be explained later. During running, the model ran continuously for 24 hours each day; and the whole sequence of operations was automatically carried out by the engine and its controls. Routine tests were made several times daily to ensure that all such conditions as mean-tide, salinity, etc., were correctly maintained. A watchman visited the laboratory twice nightly, and had instructions for action in the event of breakdown, or of failure in the electricity or water services. A careful log of working was maintained.

In the earlier experiments the rivers were supplied with silt differing in colour from that chosen to represent the tidal silt. Thus these two silts could be distinguished from each other at the close of a run, and the travel and distribution of silt from these two sources could be studied. As was expected, the river supply and tidal-silt supply tanks did not transmit to the model all the silt which was fed into them. The residues left in each tank at the close of every run were dried and weighed, and the silt feeds adjusted to give the correct net silt discharges.

Surveys were carried out by means of a sounding rod, marked in scale-feet, which moved vertically through a sliding block, running along the top of a straight-edge marked in sea-miles, divided into tenths. The large straight-edge which spanned the Gulf of Martaban was 19-ft. long and was carried by the travelling gantry. A smaller straight-edge was used in surveying the rivers. The sounding rods were moved along the straight-edge by hand, and were read directly, the soundings being immediately plotted upon specially prepared master charts. This method was laborious, but was considered to give the most reliable results. In every case the model was stopped and drained slowly before survey.

Under these conditions two trial runs were made, starting from the 1875 regime, and continuing until, by the model time-scale, the 1932 stage had been reached. Each run was interrupted for the purpose of check surveys with the actual charts of 1897 and 1910. During each of these runs further comparisons were made between model and actual tidal-waves, and the velocities and directions of the model and actual tidal-streams were compared by extensive float observations. The floats were timed over a 3-mile length, measured on a horizontal wooden bar held a short distance above high water by a vertical rod, rotating in a block attached to the survey straight-edge. The 3-mile gauge was rotated until it lay parallel to the line of travel of the floats, and a pointer on the vertical rod showed the bearing of the float-tracks on a protractor-scale. From the position of this device on the straight-edge, and the angular reading on the protractor, it was possible to fix accurately the tracks of the floats. These model observations were compared with meter readings taken by the Commissioners' Technical Staff at a number of stations in the Rangoon River and Gulf of Martaban, and were found to agree closely with them.

Each survey of the model was made by taking soundings at close intervals along the standard section-lines; these soundings were plotted directly on master charts, and contoured at intervals of one fathom, for easy comparison with the Admiralty and Port Commission charts. The general comparisons between model and actual charts were good, the principal changes being demonstrated in the various model surveys. The erodible banks of the Rangoon River, however, failed to maintain the correct side slopes, and the western extension of Middle Bank was not apparent. The deterioration of the Eastern Channel was accelerated in the model. In addition, the ripple formation inevitable in all moveable-bed models produced very much more detail in the model-contours than was visible on the actual charts.

To overcome this latter difficulty, efforts were made to show the bed movements by measuring the volume of accretion over selected areas. A rectangular 5 miles by 2 was chosen covering the scope of the Outer Bar accretions. This area was plotted on all the actual charts, and on all model-surveys, after which the average sounding within the area was in each case obtained. The progressive decrease which occurred in the average sounding within this area gave a measure of siltation. The following tabular comparison between the model and actual results shows that a close agreement was obtained.

Comparison of Actual and Model Siltation on Outer Bar.

Decrease of Average Sounding on Bar Area since 1875

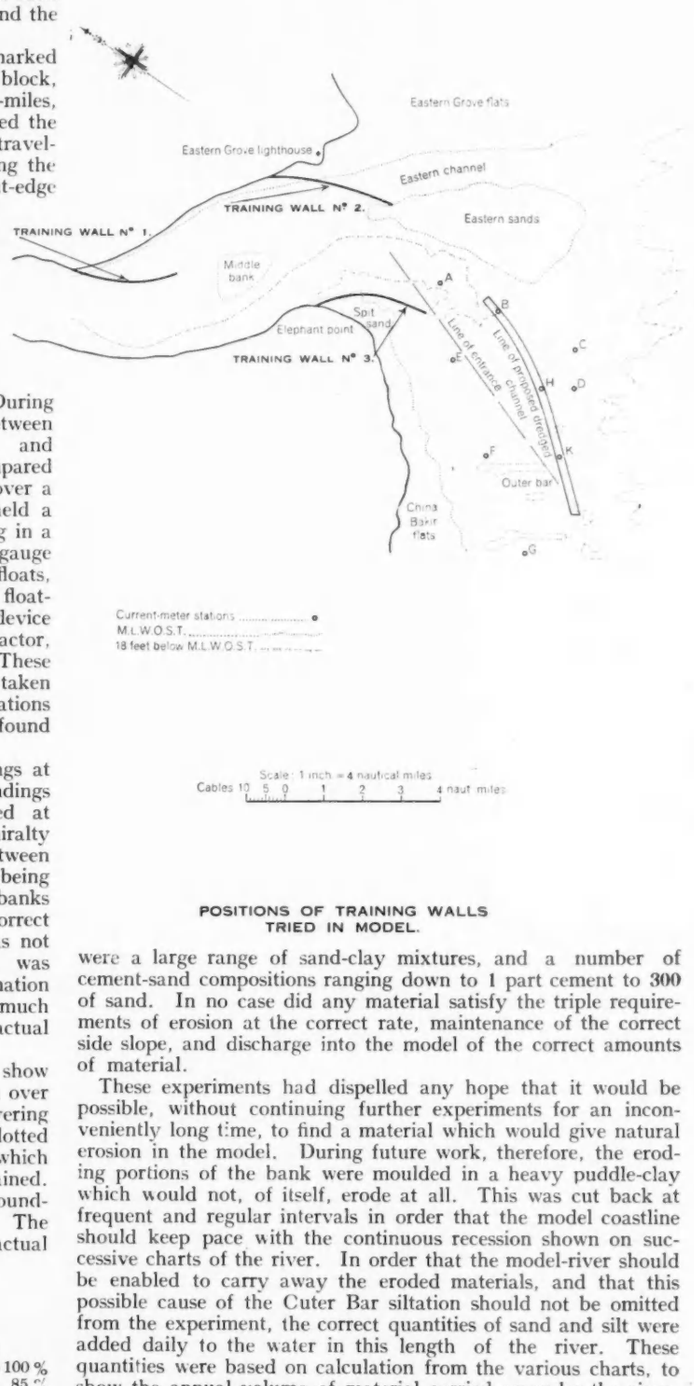
	1875	1910	1932
Admiralty and Port Commission Charts	0	3 ft. 2 in. = 51%	6 ft. 2 in. = 100 %
Model Surveys in Trial Runs... ...	0	2 ft. 8 in. = 44%	5 ft. 3 in. = 85 %

Second Series of Trial Runs

The results of the first trial runs were on the whole encouraging; the Outer Bar siltation had been faithfully reproduced and many other features had been clearly shown in the model. It was considered, however, that the method of reproducing erosion in the river banks could be improved, and that better methods could be found for observing current velocities and for tracing the travel of silty material. After some investigations into these points, it was decided to carry out two further trial runs in which the operation of the model would be thus modified.

Continued, and unsuccessful, attempts had been made to reproduce the natural erosion of certain stretches of the coastline. To test the erosion of various materials, a large number of separate experiments had been made, in a flume which was rocked so that water in it surged to and fro at a period equal to the tidal period of the model. Among the materials examined

FIG 9.



POSITIONS OF TRAINING WALLS TRIED IN MODEL.

were a large range of sand-clay mixtures, and a number of cement-sand compositions ranging down to 1 part cement to 300 of sand. In no case did any material satisfy the triple requirements of erosion at the correct rate, maintenance of the correct side slope, and discharge into the model of the correct amounts of material.

These experiments had dispelled any hope that it would be possible, without continuing further experiments for an inconveniently long time, to find a material which would give natural erosion in the model. During future work, therefore, the eroding portions of the bank were moulded in a heavy puddle-clay which would not, of itself, erode at all. This was cut back at frequent and regular intervals in order that the model coastline should keep pace with the continuous recession shown on successive charts of the river. In order that the model-river should be enabled to carry away the eroded materials, and that this possible cause of the Outer Bar siltation should not be omitted from the experiment, the correct quantities of sand and silt were added daily to the water in this length of the river. These quantities were based on calculation from the various charts, to show the annual volume of material carried away by the river. In order to obtain the approximate proportions of fine and coarse materials contained in the alluvial banks which were being thus eroded, site observations were conducted by Mr. W. D. Beatty, M. Inst.C.E., the Port Commissioners' Engineer. These showed that the ratio by weight of the fine to the coarse materials in the eroding sections was of the order of 19 to 1, and the mixture added to the model-river contained 95% of silt and 5% of sand. Experiments were made to find the weight

Port of Rangoon—continued

of this mixture occupying a given volume after the materials had settled and consolidated in water; from this relationship was determined the weight of the mixture which was daily added to the model.

The 3-mile gauge-length was found too short to allow accurate timing of floats, whose paths over some of the important areas were too curved to allow the use of a longer gauge-length. Attempts to produce a suitable form of current-meter proved unsuccessful, owing to the shallow depths in which this was required to work. Finally, a sheet of plate glass was obtained, 6-ft. by 3-ft. in size, and mounted in a strong wooden frame, which could be supported over any area by a moveable wooden gantry. By this means the glass sheet was suspended horizontally over the model, as close as possible to high water. The glass was divided into ¼-mile square by a network of threads on the underside, and was placed over any area where current readings were desired. If a float were released so as to pass beneath the plate glass, its successive positions could be recorded thereon at 1-second intervals by means of paint-spots: these formed a continuous track across the glass, and were subsequently replotted on squared paper to form a permanent record. The timing was done by a metronome arranged to beat at 1-second intervals. This scheme is due to Mr. Ralph Freeman, M. Inst. C.E., and worked perfectly.

The last and most important innovation was the development of chemical means whereby silts entering the model could be traced to their final resting places, and the constituents of the silt deposits on the sea-bed allocated to their respective sources. During the first trial runs, the two differently coloured clays used for the river silt and tidal silt had become greatly intermingled, and visual tests were found useless as a means of determining the proportions in which these two silts had mixed in forming any given deposit. A search was made for some more certain means of tracing the various silty deposits in the model, and two methods were adopted, after some weeks of investigation, during which the experimenters received a great deal of invaluable advice and assistance from the Staff of the Department of Chemistry at University College.

The first method was the use of prussian-blue powder added to the silt in small quantities as an indicator. The powder sold commercially was found to settle through water at the correct rate, and it was also found that pure prussian-blue can be easily and certainly detected in very small traces by a rapid and simple test.

The second method was an amplification of the attempts to use differently coloured clays for the river and tidal silts. Visual tests based on colour were useless, and efforts were made to discover two materials, suitable for use as model-silt, which would have similar settlement characteristics and yet have a definite and constant chemical difference. Ultimately, it was found possible to obtain and use two clays, each of which contained a different but constant proportion of titanium dioxide. Thanks to further co-operation by the Chemistry Staff of the College, a chemical test was devised whereby the analysis of a mixture of the two silts would show the proportion in which each was present. Both methods of chemical testing were simple and reliable, and the model-staff carried out all analyses in the model-laboratory.

The third and fourth trial runs, in which the above methods of working were adopted, covered the period from 1875 to 1932. In each run the model was stopped and surveyed at the 1910 and 1932 stages, when the usual contoured surveys and volumetric checks were made.

The new method of erosion was found to have many advantages, and by maintaining proper side slopes it enabled the model to reproduce with more certainty the steady westward extension in the width of Middle Bank. The silt-sand mixture added to represent eroded material was made up with the red, pigmented sand, whose movement showed that this heavy material travelled to the westward around Elephant Point, landing at the eastern end of the China Bakir flats.

Very many float-track observations were made with the plate-glass apparatus. In the third run this was used to give further comparisons of the model-currents with their prototypes. In the fourth, a standard series of observations was repeated at 10-yearly intervals to show the changes brought about by alterations in the mouth of Rangoon River. It was found that the changes were not of sufficient importance to be regarded as having any direct influence upon the growth of the Bar.

The prussian-blue tests were used during the third run to show the deposition of silt issuing from the China Bakir River, and in the fourth run to show the travel of silt issuing from the Rangoon River. In both cases the general trend of suspended silt was in an easterly direction: the analysis of samples from the fourth run showed that little or no Rangoon River silt landed on the Outer Bar. During the third run one kind of clay was introduced into the model to reproduce the silt coming from the west under tidal action, while the other was supplied to all the model-rivers. Subsequent analysis of samples from the Outer Bar showed that about 70% of the Bar was composed of the tidal silt. During the fourth run, the China Bakir River was disconnected from the other rivers, and separately supplied with water and with the same clay as that used for the tidal silt, and the Outer Bar was afterwards found, by analysis, to contain about 85% of silt from the west. Comparison of this figure with the corresponding figure derived during the third run suggested that the China Bakir River was responsible for about 15% of the total deposit on the Bar.

Examination of a large number of samples from other areas produced further evidence that the material suspended in the waters of the Rangoon River is mainly deposited on the Eastern Grove flats and in the head of the Gulf. The data resulting from the use of prussian blue invariably agreed with those resulting from the titanium tests. At the close of each run, the surface of the model was completely cleared of all silt, and the upper surface of the sand was also removed, in order that the distribution of materials in one run should in no way affect the results of the next series of chemical analyses.

The proof by the prussian blue and titanium tests, that the bulk of the silt travelled eastwards with the main stream of the flood tide, that the major part of the Outer Bar deposits had come from the China Bakir River or from further west, and that only a small proportion of the silt leaving the Rangoon River found its way on to the Bar, was considered to be one of the most valuable pieces of information obtained by the model, as there had been much controversy in the past as to the sources of material deposited on the Outer Bar and their relative importance.

At the conclusion of the four trial runs, it was considered that the working of the model was satisfactory. The various comparisons had shown that the model did give a reliable representation of actual conditions, and although the trials had extended over a much longer period than was originally anticipated, they had provided opportunity for researches yielding a great deal of information of major importance in considering means for the rectification of the Outer Bar.

Second Stage of Investigation: Predictive Runs

Two predictive runs formed the next part of the experimental work. Each of these started with the model moulded to the conditions of 1932, and continued until the 1982 stage had been reached. The conditions under which the model was operated were, with two important exceptions, kept as close as possible to those governing each of the four trial runs.

In the first place, a variation was made in the material representing the sea-bed. The four trial runs had all started with a bed moulded in sand, which was considered most nearly to represent the conditions of the sea-bed in 1875. By 1932 the Port Commissioners' charts showed that large portions of the modelled area were covered with silty material some feet in thickness, and in future runs the model was moulded with a bed of this nature.

The second change concerned the erosion of the west bank of the Rangoon River, above Elephant Point. Any prediction of future erosion was undesirable, as it might be greatly affected by any hidden variation in the nature of the eroding strata. To avoid the element of doubt, erosion in the first predictive run was reproduced at about one-tenth the actual rate occurring between 1875 and 1932, and in the second predictive run this stretch of the river bank was cut back at the actual rate obtaining between 1875 and 1932. It was considered that the truth would be found somewhere between these extremes, and that comparison of the results consequent upon these two rates of erosion would show the extent to which the regime as a whole was affected by the widening of the river.

During the two predictive runs, the float-track observations and the chemical silt-tracing tests were continued. The float observations completed the previous series made at 10-yearly intervals, and the progressive changes observed by this method during the last trial run were found to continue. Prussian blue was applied to the Sittang, and the titanium tests were repeated, during both predictive runs, to give an exhaustive check upon the conclusions previously drawn.

At the conclusion of the second predictive run, the model was operated for a further 15 years, and the rate of introduction of silt was doubled to produce the general effects of 30 years' running. In other model investigations it had been considered permissible to save time by increasing the effective rate of working of a model by generating spring tides only. In the Rangoon model, however, it was considered that the relatively quiescent periods during neap tides had important effects, and acceleration was carried out by the alternative described.

The results of the predictive runs, in conjunction with those previously obtained from the trial runs, led to the following conclusions:—

(1) The continuous siltation of the Gulf of Martaban is the material factor in the growth of the Outer Bar.
(2) The bulk of the deposit on the Outer Bar has come from the westward.

Port of Rangoon—continued

(3) The silt brought down by the Rangoon River, including that falling into it by reason of the erosion of its western bank, is of minor importance.
(4) The above-mentioned erosion has considerably straightened the lower part of the river, and the seaward end of the entrance channel is swinging to the southward, tending to cause a corresponding straightening of the bend round Elephant Point.
(5) This general straightening is merely the terminal phase of a cyclical change, and will tend to give place to a stage when further curvature will occur, further seaward.
(6) The deterioration of the approaches is unlikely to continue much beyond the present stage, and further improvement will probably occur.

Study of Remedial Works

After consideration of these points, two methods were examined whereby the limiting depth in the Port Entrance might be kept at a greater depth than would result from the action of natural forces alone. The first general method was the construction of training works to concentrate the discharge from Rangoon River, in order to increase the scouring tendencies over the areas where shoals were deposited. The second was the more direct method of dredging a channel through the Outer Bar.

The next experiments were accordingly trials of three schemes for training walls. Two were alternative methods of closing the Eastern Channel, either at the upper end of Middle Bank, where the Eastern Channel leaves the main branch of the river, or at Eastern Grove Point, with the object of closing the Eastern Channel entirely, and concentrating the river discharge into the Western Channel. The third scheme was a wall three miles long, running seaward from Elephant Point, as shown in Fig. 9, with the object of concentrating the main stream into the more southerly alignment that it was trying to adopt.

To save time, the effects of these walls were judged by measuring the increased velocities produced in the currents in the Western Channel and over the Outer Bar. It was considered that, as training walls operate principally by their effects on currents, this would give all necessary information as to the efficiency of the walls, and would avoid the lengthy process of remoulding the model before trying each wall, and of running it for a considerable period in each case. This method of examination was made possible by the development by Mr. T. L. Norfolk, M. Inst. C.E., of a new type of current-meter, which was used by him in the model of the Mersey Estuary. The device consists of a small bead suspended in the water by a fine hair. Any motion of the water will deflect the bead from its vertical position; the amount of the horizontal deflection bears a definite relation to the velocity of the stream, and is determined by calibration, while the direction of the deflection is, of course, the same as the direction of flow. The deflection is measured by a vertical sighting tube, which is continually moved by hand so that the bead remains in the line of sight. As the tube carries an autographic recording pencil operated 15 times per tide by a special switch on the main engine, the pencil draws a polar graph of successive positions of the bead.

To simplify the work, the model was operated without siltation and under continuous monsoon conditions, and a series of spring and neap-tide current readings was made at standard points on the Outer Bar. The Eastern Channel was then closed completely by the first training wall, and the whole series of current observations was repeated, after which the training wall was removed and the original observations checked. The routine was repeated with each of the other two training walls, and a similar series of observations was also made with the Eastern Channel completely filled up, as though by natural siltation. The two walls above the Eastern Channel were built above high water, but the third, from Elephant Point, was tried at various heights to see how low it could be kept. After these tests, the wall was left in position and the model operated for a short time under normal conditions and with normal siltation, in order to study its effects on the regime.

These experiments showed that in each case the effect of the training wall was entirely local, and that no effect over the Outer Bar was discernible. The third wall, extending south-east from Elephant Point, was found to act as a trap for the silt travelling eastwards along the coast, and materially accelerated the advance of the China Bakir flats; the adoption of a scheme of this type would ultimately have required a continuous programme of extensions. Without considering the probable cost of such training works, it was obvious that they could serve no useful purpose in this case.

Dredging formed the subject of the next investigations. From the experimental results as a whole, it was possible to suggest a suitable location for a dredged cut through the Outer Bar, arranged to take the fullest possible advantages of existing natural conditions, and of probable future tendencies. The location of this cut is shown in Fig. 9; six miles in length, it started at the end of the southern fork of Western Channel, and curved gradually round until parallel to the 1910 fairway, and about two miles south of it, continuing in this line until deep water was reached.

This channel was tried in the model, which was first remoulded to the actual 1932 condition. The model was operated until the 1936 stage, and then an assumed dredging programme was carried out during four consecutive dry seasons. After the completion of dredging, 12 years' normal running was allowed before the model was stopped and surveyed, to measure the deterioration of the channel.

The model-channel was made equivalent to a 400 yards bed width with side slopes of 1 in 5, and had a ruling depth of 18-ft. at low water. After the first examination of the channel, a second channel of the same cross-section was dredged along a line near to the first channel, but normal to the main stream of tide, and a further 12-years' test run was made. Measurements were taken to show the comparative rates of siltation in the model-channel dredged with the streams and that dredged across them, to find out the degree to which a model could be used to study such matters. The channel, whose alignment lay parallel to the direction of flow, was found to be the more permanent, but the difference between the two channels was very much smaller in the model than would probably be the case in actual fact, since the siltation of the model cross-channel was considerably affected by the ripple formation. This was taken into account when considering the possibilities of dredging from the full-size point of view.

In the actual dredging of the model-channels, the bed material was stirred up by a rotating templet and carried away by the flood tide. The channel was dredged gradually from the inshore end, and the strip of sea-bed on the site of the proposed channel was moulded with a percentage of prussian blue, by which the material agitated by dredging was subsequently traced. It was found to have travelled in an easterly direction.

Further experiments were later carried out to test the suitability of a suggested dumping ground for dredgings removed by more usual methods. Prussian blue powder was dumped in the area at the appropriate states of tide, and a series of samples subsequently analysed showed the final location of the material. The site selected was abreast of the mid-point of the proposed dredged channel, and was about four miles further seaward: the tests showed that the dredged material neither entered the Rangoon River nor drifted back into the cut.

Before and after dredging, a full series of current-observations was made at a number of stations along the line of the channel and at points in the areas on either side. These current-observations showed clearly that the model-channel had a pronounced effect in improving the currents over the Outer Bar areas. The improvement was most marked in the deeper stretches of the cut, and tended to fall off as the channel slowly filled.

Measurements were made comparing the rates of siltation in the channel and over the areas on either side of it; thus it was possible to form some idea of the relative permanence of the channel. It appeared that a channel on the lines indicated would probably last for a fair time without undue maintenance, though it was not considered possible to estimate exactly the extent to which maintenance would be necessary.

Final Decisions

With these tests the experimental work came to a close after having been in progress for over three years. The final report was submitted to the Commissioners towards the end of 1935. In this it was pointed out that while the port was not threatened by eventual extinction, it was evident that some limitation on the draught of vessels using the port would be inevitable unless rectification of the approaches was carried out by artificial means. The possibility of a dredging programme was outlined which, with some initial expenditure and a not excessive amount of maintenance, dredging would make reasonably certain of a satisfactory and permanent approach channel.

The Report suggested that it was possibly unjustifiable for any port to incur large capital expenses to benefit a small section of its trade. Works constructed to benefit the deeper vessels must be paid for mainly out of shipping dues: thus a large proportion of traffic is penalised. Beyond a certain point increase in dues must hamper trade as much as physical obstructions, and there must be for any port an economic limit to the draught of shipping.

On receiving the Final Report, the Commissioners carefully reviewed the policy to be adopted for the port and its entrance channels. It was decided not to proceed with a scheme of major dredging operations over the Outer Bar, and to advise shipowners that the port cannot in future deal expeditiously with vessels drawing more than 28-ft. of water, so that future shipbuilding programmes can be formulated on this basis. The decision was issued to the shipbuilding world and to the Press in a statement dated the 15th May, 1936, which has been published elsewhere. The limits prescribed for this Paper, unfortunately, do not allow a full treatment of this subject.

Port of Rangoon—continued

Acknowledgments

During the course of the experiments, much active help was given and many valuable suggestions were made by persons not immediately concerned with the work. The Author has to thank Professor E. G. Coker, M.A., D.Sc., F.R.S., M. Inst. C.E., and his successor, Professor G. T. R. Hill, M.C., M.Sc., and other members of the Staff of the Faculty of Engineering at University College, London. The success of the chemical investigations was very largely due to the assistance of Professor F. G. Donnan, C.B.E., M.A., LL.D., Ph.D., D.Sc., F.R.S., and Mr. Henry Terrey, B.Sc., of the Faculty of Chemistry at the same College. Advice was also obtained from the Departments of Physics and Geology.

The Author is indebted to the Commissioners for the Port of Rangoon, and to Sir Alexander Gibb and Partners, for their permission to publish this paper, and to Mr. J. Guthrie Brown, M. Inst. C.E., with whom the Author was associated in the model-experiments, for his very kind assistance in criticising the proofs.

Mention is also due of all those who worked in the model-laboratory, and who assisted the Author throughout the course of the investigations.

Greenock Harbour Projects

Postponement of Important Improvements

At a meeting of the Greenock Harbour Trust held on August 17th last, there was under discussion a scheme, estimated to cost £140,000, for the reconstruction of Princes Pier, and the improvement of the Garvel Graving Dock and Entrance Basin. Owing to a divergence of opinion among the members, a decision was not arrived at and the matter was deferred for consideration at the ensuing meeting, at which Mr. J. L. Johnstone, one of the bondholders, gave notice of his intention to move the following resolution:—

" That the reconstruction, or repair of Princes Pier being an urgent matter and (1) the Sub-committee on Works having had various proposals for the financing of the work under consideration since September, 1935; and (2) there being no more prospect of agreement upon the present elaborate scheme than upon the previous ones, it be forthwith abandoned and the Sub-committee instructed to confine their deliberations to a scheme for Princes Pier only, the financing of which could be met with the existing powers and constitution of the Trust."

The next meeting of the Trust was held on September 21st, when it was decided not to proceed with the scheme.

In broaching the subject, Mr. W. S. Coutts, the chairman, referred to the change in the conditions due to the outbreak of war, and said that so far as the reconstruction of the Princes Pier and the graving dock was concerned, he did not think it would be of practical value to discuss the matter at the present time. With regard to Princes Pier, not only would it be impossible to put the pier out of commission for reconstruction, but it was exceedingly doubtful whether labour or material would be available. The same thing applied to the Garvel Graving Dock.

There were two other difficulties—one was the impossibility of getting a Provisional Order through Parliament under present conditions. The other, and perhaps the most important one, was the fact that the Commissioners for Special Areas was no longer in a position to give a loan. In these circumstances he suggested that the matter be allowed to lie on the table, and he moved accordingly.

Bailie Ross seconded and the motion was unanimously adopted.

In amplification of the chairman's remarks, it may be added that the Commissioner for Special Areas in Scotland had made an offer for a loan up to a maximum of £90,000 repayable, principal and interest, within 50 years, at 3%, or put in another way, repayable in 50 years by annual instalments of £3,500. The condition was laid down that all the works would have to be done and that they should be started not later than March 31st, 1940. A further £50,000 being required to meet the cost, the Greenock Dockyard Company, who lease the Garvel Graving Dock, were prepared to advance about £30,000 conditionally on their getting a lease of the dock for thirty years and also an option on the extension of the lease of their shipyard for a similar period. It was proposed to find the balance of £20,000 by drawing on revenue over the period of renewing Princes Pier, a sum of say £10,000, and by taking an amount of £10,000 from the Reserve Fund for the deepening of the basin.

The bondholders' representatives were opposed to the proposals concerning the Graving Dock and Entrance Basin and the motion tabled by Mr. Johnstone, recorded above, represented their views on the matter.

Book Review

A New European Waterway

Le Canal Albert, by A. Delmer, Secretary-General of the Belgian Ministry of Public Works. With 105 photographs and 50 plans and diagrams. Vol. I., Text 384 pp. Vol. II, 19 plates and a coloured chart. Price: 60 francs (Liège, 1939, M. Georges Thone).

The great Belgian inland waterway linking the Port of Antwerp with the industrial city of Liège, initiated by the late King Albert, and now at the point of completion, has been an undertaking of so great magnitude and such striking importance that an official detailed account of its inception and accomplishment is in every way a necessary corollary of the work, besides being the medium for a well-merited tribute to the illustrious monarch, under whose direction it was planned and commenced. Monsieur Delmer, who was a member of the Bouckaert Commission, appointed in 1923, to examine the various schemes and projects which had been put forward for a waterway between the two cities, and was subsequently Secretary of the National Commission, 1927, which determined the route to be taken, has discharged his responsible task with commendable skill and judgment. As a history, the book will rank with the best of those recording enterprises of national importance, and as a statement of matters on which there was bound to be pronounced differences of opinion, it is fair and impartial in its presentation of the facts.

Fundamentally, the Canal Albert is the realisation of the Belgian national aspiration to possess a waterway connecting its industrial centre of Liège with the Scheldt and the open sea, which should lie entirely within Belgian territory. Holland had already set the example of a national waterway linking Maasbracht with Maastricht within the limits of the Netherlands, in the adjacent Canal Juliana. The Canal Albert was the Belgian rejoinder. " Le Canal Albert, replique du Canal Juliana, fut la réponse du berger à la bergère."

The book opens with an historic resumé of the course of events which led up to the project of the canal, and a statement of the various schemes which preceded the adoption of the approved plan. Succeeding chapters discuss the economical and political reasons for the construction of the canal, its importance from the point of view of national defence, the constructional difficulties of the route and the financial and administrative organisation of the undertaking. The characteristic features of the work are then detailed (longitudinal profile, transverse section, locks, bridges, ports, alimenation works, etc.) followed by a description of different sections of the canal and its branches. Interesting statistics are given about the execution of the work and its cost, and there is an exposition of the results achieved, the system of exploitation and the future prospects of the canal. There are three appendices, one of which is an excellent bibliography, the second, a table with particulars of the bridges, and the third, a list of contractors engaged on the work.

The second volume consists entirely of a set of charts, diagrams and plans referred to in the text of the first volume.

The book is well documented, carefully compiled and forms an admirable work of reference on the subject about which it treats.

Extensions at the Port of Basle.

It is reported that the Cantonal Council have authorised an expenditure of 1,709,850 francs on quay extensions at the inland river Port of Basle within the Cantonal Jurisdiction.

The Institution of Civil Engineers.

It is announced that the Council of The Institution have decided to continue, as far as may be practicable, the work of The Institution from the headquarters building in Great George Street, Westminster, S.W.1. The meetings of the Institution in London will be suspended until further notice, and the Conference on Engineering Education and Training and the Road Engineering Exhibition are postponed indefinitely.

The Institute of Transport.

The Institute of Transport announce that the outbreak of war renders necessary a curtailment of the activities of the Institute during its early stages, at least. Mr. T. E. Thomas will be inducted as the President for the Institute year, 1939-40, and will deliver his Presidential Address on Monday, October 9th, 1939, as already announced but at the Charing Cross Hotel, Strand, London, W.C., at 2.30 p.m., not at the Institution of Electrical Engineers at 5.30 p.m.

The Handling and Storage of Grain*

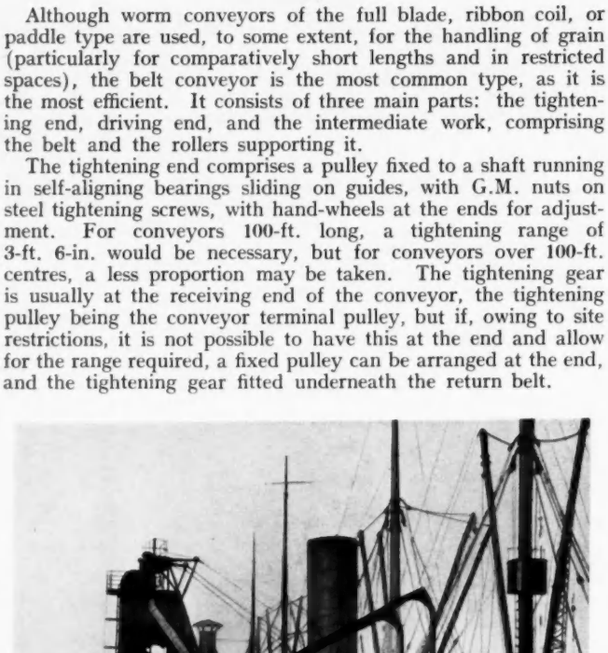
By ERNEST BEALING, A.M.I.Mech.E., A.M.I.Struct.E.

(Continued from page 338)

Conveyors

Although worm conveyors of the full blade, ribbon coil, or paddle type are used, to some extent, for the handling of grain (particularly for comparatively short lengths and in restricted spaces), the belt conveyor is the most common type, as it is the most efficient. It consists of three main parts: the tightening end, driving end, and the intermediate work, comprising the belt and the rollers supporting it.

The tightening end comprises a pulley fixed to a shaft running in self-aligning bearings sliding on guides, with G.M. nuts on steel tightening screws, with hand-wheels at the ends for adjustment. For conveyors 100-ft. long, a tightening range of 3-ft. 6-in. would be necessary, but for conveyors over 100-ft. centres, a less proportion may be taken. The tightening gear is usually at the receiving end of the conveyor, the tightening pulley being the conveyor terminal pulley, but if, owing to site restrictions, it is not possible to have this at the end and allow for the range required, a fixed pulley can be arranged at the end, and the tightening gear fitted underneath the return belt.



Floating Elevator at the Port of Liverpool. Capacity, 200 tons per hour.

In some cases, an automatic tightening gear, with suspended balance weights, is arranged, to ensure a constant tension in the belt when it is subjected to changes in humidity or temperature.

Conveyor belts are usually of similar construction to elevator belts, as previously described, but instead of being jointed on site, they are generally made endless.

The carrying side of a conveyor belt is supported on rolls at from 5-ft. to 6-ft. centres, and the return side on rolls from 10-ft. to 12-ft. centres.

Conveyor belts can be either flat or troughed, the advantage of troughing the belt being that increased capacity is obtained for the same width of belt.

In the case of flat belts, the top and bottom rolls are flat, and usually consist of a number of rolls 5-in. diameter, fixed to a steel spindle, rotating in bearings in short C.I. stands, the bearings being of the plain grease or ring-oiling type, but if ball-bearing rolls or idlers are used, the spindle is fixed in brackets and the rolls rotate on the spindles, and at intervals along the belt, a set of curving rolls is fitted to keep the grain central on the belt, also to assist the belt to run true.

*Paper recently read at the Canterbury Technical Institute by the London Representative of Messrs. Spencer (Melksham), Ltd.

For troughed belts, the carrying side of the belt is frequently supported on several horizontal rolls, the number and length depending on the width of belt, and inclined rolls are separately arranged on one side, but the most modern practice is to arrange the horizontal and inclined rolls in line, with the spindles mounted in cast-iron brackets bolted to cross trays attached to the longitudinal stringers.

The usual speed of grain conveyors is 550-ft. per minute, although for larger capacities, 700 or 800-ft. per minute is quite common.

The capacity of a troughed belt is roughly 50% more than that of the same belt flat.

The driving end of a conveyor is usually at the delivery end, and consists of a pulley fixed to a shaft running in bearings, one end of the shaft being extended and fitted with spur wheel or chain wheel, to receive drive from motor. The driving end of a conveyor over 100-ft. centres is usually fitted with a press-pulley on the underside, to increase the arc of contact of the belt around the driving pulley, and so increase the driving effort.

To determine the h.p. required to drive a belt conveyor, it is necessary to consider the friction in the rollers caused by the empty belt, also the friction due to material carried on the belt, and if these two amounts are multiplied by the speed, and divided by 33,000, the h.p. is obtained.

Authorities vary considerably over the power required to drive belt conveyors, but the following formula by Haddock is one very widely used:—

If W 1 = total weight of conveyor belt in lbs.,
W 2 = total weight of material on conveyor at any time,
S = speed in feet per minute,
it has been found that the theoretical h.p. required to drive a horizontal belt conveyor with plain grease lubricated bearings is:

$$\frac{(.15 \times W1 + .07W2)\ S}{33{,}000}$$

and if the conveyor is inclined, it is necessary to add for the lift, which is based on the same calculations as an elevator, i.e.:—

$$\text{H.P. for lift} = \frac{T \times H}{884}$$

If the total h.p. to drive a belt conveyor is known, one can easily determine the tension in the belt, and thus fix the ply. If the h.p. is multiplied by 33,000 and divided by the speed of the conveyor, we have a result in lbs., which is the h.p. pull or effective pull. It is not the actual pull in the belt, but the difference in tension between the belt on the tight side and on the slack side, as they enter and leave the driving pulley, or, if T 1 and T 2 are these two forces, the effective pull is:—

$$\frac{\text{H.P.} \times 33{,}000}{\text{speed}} = T\,1 - T\,2.$$

By considering the angle of wrap of the belt round the head pulley and the friction between the two surfaces, we can find the ratio of the tensions: $\frac{T\,1}{T\,2}$; by combining this with T 1 – T 2, we determine the actual values of T 1 and T 2, and the ply of the belt is then fixed by dividing T 1 by the width of belt, multiplied by safe stress per ply.

It has been found that, when a belt just slides on a pulley, the relation of T 1 and T 2 is expressed by the formula:—

$$\frac{T\,1}{T\,2} = E^{U\theta},$$ where E = base of naperian logs,
U = coefficient of friction
θ = angle of wrap,

and these values can be found by referring to tables; thus, if the coefficient of friction is .3, and the angle of wrap is 200°,

$$\frac{T\,1}{T\,2} = 2.85.$$

The following table gives the capacity of flat belt conveyors of various widths at a speed of 550-ft. per minute, and the theoretical h.p. for conveyors 100-ft. centres, but for actual h.p., add 20 to 50% (depending on driving, tightening arrangements and throw-off).

Width of Belt	6-in.	8-in.	10-in.	12-in.	14-in.	16-in.	18-in.	20-in.	22-in.	24-in.	26-in.
Capacity in T.P.H. ...	4	6	12	20	30	45	60	75	90	105	120
H.P. for 100-ft. centres ...	.38	.47	.6	.78	1.0	1.2	1.4	1.9	2.12	2-4	2.6

Handling and Storage of Grain—continued

It should be noted that, to assist the belt to run true, the terminal pulleys should be slightly crowned.

Conveyors under bins are usually fitted with travelling feed hoppers to receive the feed from any bin in the rows above, and this consists of a small feed chute mounted on a travelling carriage, which can be locked in any position.

Conveyors over bins are required, to deliver the grain into bins in a row both below and to each side, and for this purpose the conveyors are fitted with travelling throw-offs or trippers; this consists of a pair of pulleys, so arranged that the grain is raised well above the normal height of the conveyor belt, and is delivered into a chute with branches to the side, for delivery to the bin inlets. The pulleys and chute are mounted on a travelling carriage, which can be locked in any position. Steel chutes for dry wheat should be inclined at an angle of about 33°-35°, and the width of chutes feeding on to conveyors should not be more than about half the width of the belt, to allow for spreading of the material past the delivery point. At points in chutes where grain changes direction, or where there is an appreciable impact, either pockets should be arranged in the chute, or else, renewable wearing plates.

If it is required to take a varying amount of grain from a number of bins simultaneously, for mixing purposes, mixers or measurers are fitted between the underside of bins and the conveyors. These consist of a horizontal drum (containing pockets of varying volumes, controlled by slides) fixed to a revolving shaft, or operated by means of an eccentric, or pawl and ratchet gear with variable strokes.

When grain in a bin becomes too hot, it is " turned over " by emptying the bin and turning it into another bin, and its contact with the atmosphere (in passing along the conveyor at the bottom, up an elevator, and along a conveyor over bins) reduces its temperature to normal.

Owing to the dust which is given off at each delivery point, it is customary to provide a dust-collecting plant, arranged to exhaust from the delivery points of all conveyors, elevators, weighers, separators, etc., and portable sweep-up attachments are provided for connecting up to the fixed piping.

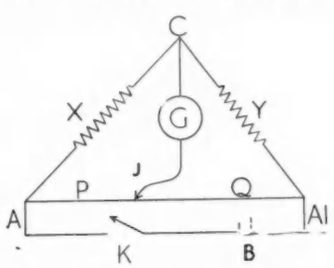
Temperature Indicating System

Grain which arrives in doubtful condition is liable to heat spontaneously, and the process of " turning over " of the grain periodically is an expensive matter, so that an accurate and reliable means of determining the temperature of the grain in storage bins is essential.

Several attempts have been made to produce a satisfactory system of Electrical Indication of Grain Temperatures, most of which have had serious inherent defects, which has made the readings obtained very unreliable—such as the thermo-couple principle, where the slightest bad contact seriously affects the accuracy of the reading, and also makes the grain appear at a safe temperature when, actually, it is over-heating.

A good system is based on the fact that the electrical resistance of a wire of almost any metal varies with temperature, and means are available whereby the change of resistance can be simply measured with extreme accuracy.

In the case of the special metal used for making thermometres, the relationship between resistance and temperature has been determined within .01% from 0° to 500° F.



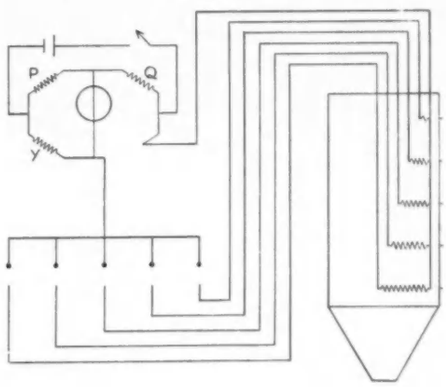
The system adopted is based on the principle of a "Wheatstone's Bridge," which, in a simple form, consists of a slide wire (A–A1) of uniform cross section and resistance, in parallel with two resistances (X and Y) in series, an Indicator or Galvanometer (G), with a sliding contact (J), a battery (B), and a key (K), being connected as shown. If it is required to measure the resistance of X, the slider (J) is moved along the wire (A–A1), and when G shows no deflection when Key (K) is depressed, (i.e., zero potential difference between C J), then X : Y = P : Q. Hence, if Y is known, we have the unknown value as:—$X = \frac{YP}{Q}$.

It will be seen that, since the coil X is made of metal, the resistance of which varies greatly with temperature, if placed in grain, its resistance is dependent upon:—

(a) the temperature of the grain;
(b) the area of the cross-section of the wire;
(c) the length of the wire, and
(d) the material of which it is composed;

and since " a " is the only variable quantity, the alteration in resistance is entirely due to the rise or fall of the grain temperature. Applying this arrangement for indicating the grain temperature, the arms of the bridge can be so arranged that no current passes through the Indicator or Galvanometer, when the coil X is at the same temperature as the atmosphere above the bins. An increase, therefore, in the temperature of the coil X causes a deflection of the Galvanometer, the scale of which is calibrated to read directly in degrees of temperature corresponding to the increase of resistance.

The apparatus consists of an indicator and a selecting switchboard, generally placed in a central position over the bins, or it can be erected in an office on the ground floor. From the switchboard, small cables are run, and connected to small coils of special wire placed every five or ten feet apart in the grain,



the arrangement being as shown in the diagram. The wires leading into the grain, for connecting to the thermometers, are enclosed in special heavy steel tubes, designed to withstand the pressure of the grain, and also the pull of the grain when the bins are emptied. The tubes are supported at the top, on a special fitting, and are free to swing at the bottom. The wires from the bins terminate on lever switches on the switchboard, designed to close the thermometer and battery circuit with one movement, and the switches are engraved to indicate the exact position in the bin of the thermometer to which they are connected.

The whole of the apparatus is worked by a 1.5-volt cell, and the current consumption is so small that the cell should only require renewing once yearly.

Electrical Equipment

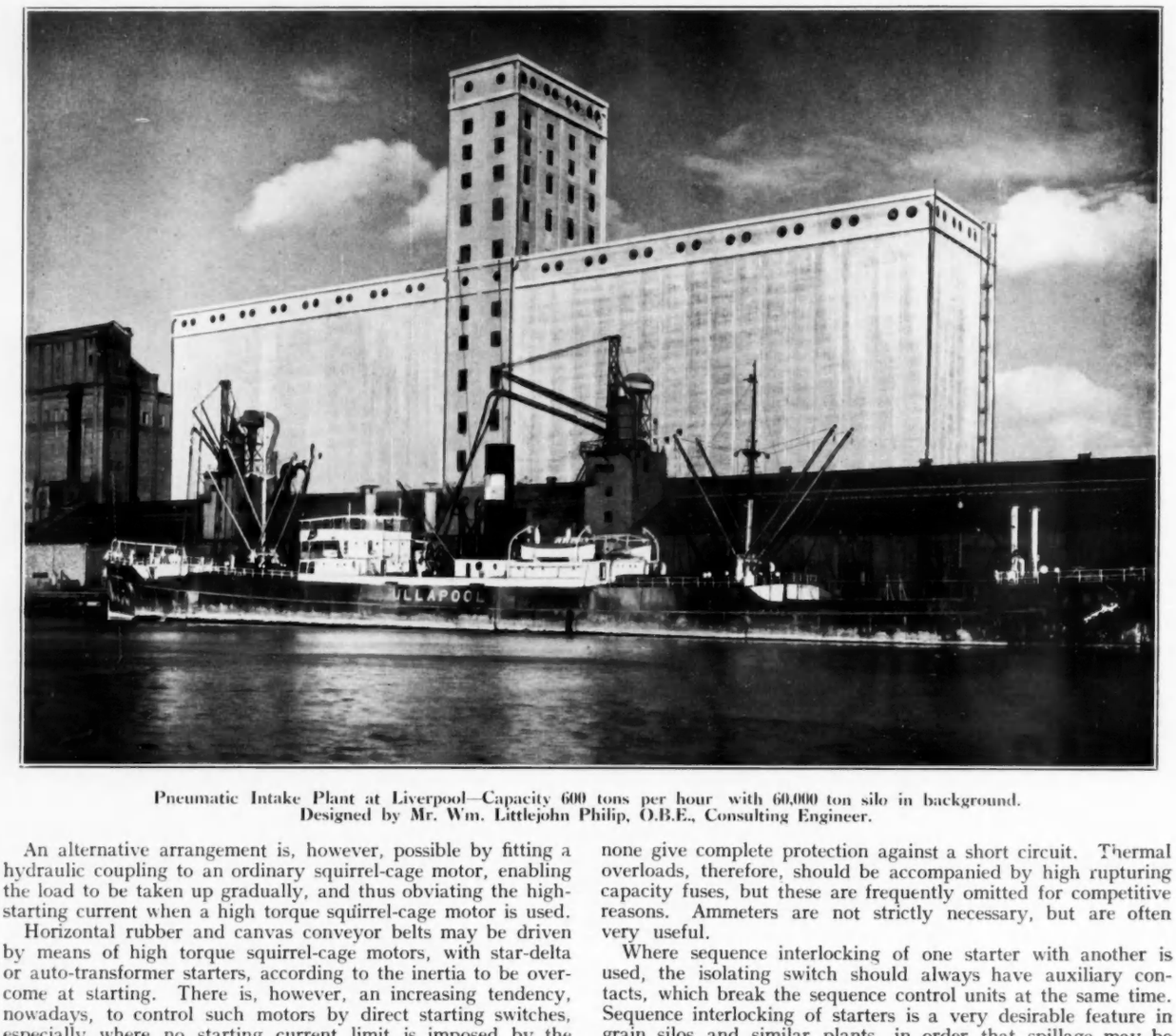
The standardisation of electric supplies throughout the country, to 3-phase, 50-cycles alternating current, has reduced the available types of electric motors and control gear from which to choose for driving grain plant. There are, of course, many instances where direct current or single phase A.C. is still in use, and these call for separate consideration. The principal considerations to be taken into account when choosing a motor for a particular duty are: starting torque in relation to full-load torque, and duration and frequency of starting periods. In applying these considerations to grain handling plant, we have to take into account the various starting efforts necessary to overcome the inertia of widely different classes of mechanical plant, as, for example, elevators and the different classes of horizontal and inclined conveyors.

The modern grain elevator is actually a balanced piece of apparatus, and in theory, the torque required to start and accelerate it are not great, in comparison with the full torque of the driving motor, and from this, it would appear that a squirrel-cage motor would be satisfactory; this is not the case, however, as when an elevator is in operation, a considerable amount of grain accumulates in the boot, due to spillage from the buckets and excess of feed. The motor of an elevator, suddenly stopped under these conditions, is normally required to start at against a heavy torque, due to dredging the buckets through the accumulation of grain, and to exert the required torque, without excessive starting current demand from the line, definitely calls for a slip-ring type of motor. These remarks also apply for the driving of reciprocating pumps of a pneumatic plant, where the inertia to be overcome at starting is very great, and the period of acceleration long.

A specially designed high-starting torque squirrel-cage motor, started by direct switching to line, could do the work, but only with a starting current equal to five or more times the normal full-load current of the motor.

The majority of electric supply authorities lay down a maximum percentage of starting currents which shall be imposed on their mains, therefore the maker of grain elevators normally selects a slip-ring motor for this duty, and in the long run, it is to the advantage of the users of the plant, because excessive and unnecessary flexing of rubber belts is avoided, and their working life accordingly prolonged.

Handling and Storage of Grain—continued



Pneumatic Intake Plant at Liverpool—Capacity 600 tons per hour with 60,000 ton silo in background.
Designed by Mr. Wm. Littlejohn Philip, O.B.E., Consulting Engineer.

An alternative arrangement is, however, possible by fitting a hydraulic coupling to an ordinary squirrel-cage motor, enabling the load to be taken up gradually, and thus obviating the high-starting current when a high torque squirrel-cage motor is used.

Horizontal rubber and canvas conveyor belts may be driven by means of high torque squirrel-cage motors, with star-delta or auto-transformer starters, according to the inertia to be overcome at starting. There is, however, an increasing tendency, nowadays, to control such motors by direct starting switches, especially where no starting current limit is imposed by the Supply Authority.

It is customary, in grain silos, to have totally enclosed motors, as the grain dust, after absorbing moisture, develops corrosive characteristics which are damaging to electrical equipment, and there are many cases where trouble and expense has originated solely from this cause.

The use of fans within totally enclosed motors, to dissipate heat, has led to greater outputs from given frame sizes, and in consequence, the modern totally fan-cooled motor is not a great deal more costly than its screen-protected counterpart, and the extra cost is a well-spent premium against the development of electrical faults.

Where direct current only is available, the slip-ring type of motors would generally be replaced by lightly compounded interpolar machines for elevators, and shunt interpolar for conveyors.

On single phase A.C. supplies, a high starting characteristic can be obtained from either the slip-ring repulsion start-induction run, or capacitator types. Care must be taken to avoid single phase split phase A.C. motors, except in cases where a fast and loose pulley or centrifugal clutch forms part of the drive, on account of the low starting characteristic of this type of motor.

It is not easy to lay down any hard and fast rule covering control gear, as so much depends on how the plant in a silo will be operated.

If remote control of the various motors is required from one or more central points, than air break contactor gear, with separate push-button switches, is best. If, however, it is required that the operator shall personally see each driven unit before he actually starts up the motors, then hand-operated control gear adjacent to each motor meets the case.

In general, the best modern practice calls for the following auxiliaries or control gear: main isolating switch breaking all poles of supply, adjustable magnetic overload (or over-current) releases with adjustable time lag device on all poles. It may be mentioned that thermal overload releases are often met with, and while some are satisfactory for general protective purposes, none give complete protection against a short circuit. Thermal overloads, therefore, should be accompanied by high rupturing capacity fuses, but these are frequently omitted for competitive reasons. Ammeters are not strictly necessary, but are often very useful.

Where sequence interlocking of one starter with another is used, the isolating switch should always have auxiliary contacts, which break the sequence control units at the same time. Sequence interlocking of starters is a very desirable feature in grain silos and similar plants, in order that spillage may be prevented, should a unit inadvertently stop. Such sequence interlocking may be of the straight series fixed sequences, parallel sequences, or selective sequences type, and this is best determined after consideration of the actual working conditions.

The Author's thanks are tendered to Mr. Littlejohn Philip, Consulting Engineer for the Liverpool Silo, for details of construction, and to Messrs. Spencer (Melksham). Ltd., for the use of their publications and the loan of blocks, as also to "Milling" for the loan of blocks of the diagrams.

Prosperity of South Wales Ports.

Up to the date of the outbreak of hostilities with Germany, there had been evidence of a striking improvement in the volume of both exports and imports at ports in South Wales and Monmouthshire. The returns to August 20th last showed an increase in twelve months of 722,000 tons, reaching a total of 16,495,000 tons. With the exception of Port Talbot, every one of the six chief seaports in the district achieved an increase. According to the returns, as published in "The Times," there was a welcome advance in the exports of coal, coke and patent fuel, the figures of which surpassed those of last year. A total of 12,595,000 tons were shipped, an increase of 97,000 tons, despite the many difficulties encountered through the restrictions imposed by foreign countries, the vagaries of exchange rates, and in the early part of the year, the intensive competition of German and Polish coals. As regards the iron and steel trade, there was a decrease of 15,000 tons in the exports of iron and steel rails and ironwork, but an increase of 16,000 tons was shown in tinplates. The import trade of the six ports in the period showed an increase of 568,000 tons over the corresponding period of last year. This increase is mainly due to iron ore, timber and deals, grain, oil, and general merchandise. There was also a sharp increase in copper ores. The imports of semi-manufactured iron and steel totalled 386,000 tons, an increase of 54,000 tons. Crude oil imports showed an increase of 89,000 tons.

War-time Control of Ports in the United Kingdom

The following extracts from the Defence Regulations, 1939 (H.M. Stationery Office, Price 1s.) issued by the Government in pursuance of the Emergency Powers (Defence) Act, 1939, relate to the war-time control of ports in the United Kingdom.

Section 74.—(1) Without prejudice to any navigation order, a competent authority, if it appears to that authority to be necessary or expedient so to do in the interests of the public safety, the defence of the realm or the efficient prosecution of war, or for maintaining supplies and services essential to the life of the community, may make provision by order—(a) for prohibiting or restricting the shipping or unshipping of articles or persons, or any specified class of articles or persons, at any port in the United Kingdom; (b) generally for regulating, facilitating or expediting the traffic at any such port; and an order under this Regulation may contain such incidental and supplementary provisions as appear to the competent authority to be necessary or expedient for the purposes of the order

(2) The reference in the preceding provisions of this Regulation to shipping or unshipping shall be construed as including a reference to embarking on or putting on board of seaplanes or disembarking or unloading from seaplanes.

(3) For the purposes of this Regulation, the competent authorities shall be the Board of Trade and the Minister of Transport.

(4) This Regulation shall, in its application to Northern Ireland, have effect as if for the reference to the Minister of Transport there were substituted a reference to the Secretary of State.

Section 75.—(1) Any person authorised by a competent authority to act under this Regulation may, if it appears to him to be necessary so to do for the purpose of preventing or avoiding any undue congestion of traffic at any port or railway premises, cause to be removed from the port or premises, and to be kept at such place in the United Kingdom as he thinks proper, any goods at the port or on the premises which are not removed therefrom with reasonable dispatch by or on behalf of the consignee.

(2) For the purposes of this Regulation, the competent authorities shall be the Board of Trade and the Minister of Transport.

(3) This Regulation shall, in its application to Northern Ireland, have effect as if for the reference to the Minister of Transport there were substituted a reference to the Secretary of State.

Section 76.—(1) The Minister of Transport may by order make such provision as appears to him to be required in the interests of safety for regulating the shipping, unshipping, handling, storage and conveyance of ammunition, explosives and inflammable substances in the area of any harbour authority in the United Kingdom; and an order under this paragraph may abrogate or modify any restriction imposed by or under any Act in relation to the shipping, unshipping, handling, storage or conveyance of ammunition, explosives or inflammable substances in any such area.

Any such order as aforesaid may be made so as to apply either to the areas of all harbour authorities in the United Kingdom or to the area of any particular harbour authority therein.

(2) Nothing in any restriction imposed by or under any Act in relation to the area of any harbour authority in the United Kingdom shall apply: (a) to the shipping, unshipping, handling, storage or conveyance in the service of his Majesty, or under instructions given on behalf of his Majesty of ammunition, explosives or inflammable substances; or (b) to the conveyance of ammunition, explosives or inflammable substances in any vessel for purposes of defence.

(3) Any reference in this Regulation to shipping or to unshipping shall be construed as including a reference to putting on board of seaplanes or to unloading from seaplanes, as the case may be.

(4) This Regulation shall, in its application to Northern Ireland, have effect as if for the reference to the Minister of Transport there were substituted a reference to the Secretary of State.

Lights, buoys and beacons for the purpose of aiding navigation are covered by an earlier section of the Regulations, which reads as follows:—

Section 44.—(1) Except under permission granted by or on behalf of the Admiralty—(a) no light, buoy, beacon or other apparatus used in the United Kingdom for the purpose of aiding navigation in or on the water, or being under the control of a general lighthouse authority under the Merchant Shipping Act, 1894, shall be discontinued, altered or removed; and (b) no variation shall be made in the mode of exhibiting or operating any such light, buoy, beacon or other apparatus.

(2) The Admiralty, and any person acting on their behalf, may, if it appears to them or him to be necessary in the interests of the public safety or the defence of the realm so to do, give directions for prohibiting or restricting the exhibition or operation of, or requiring the removal, alteration or concealment of, or the making of any variation in the mode of exhibiting or operating, any such light, buoy, beacon or other apparatus as aforesaid.

(3) If this Regulation, or any direction given under this Regulation, is contravened or not complied with in the case of any light, buoy, beacon or other apparatus, the person responsible for the maintenance of the light, buoy, beacon or apparatus, as the case may be, shall be guilty of an offence against this Regulation; and, in the case of a failure to comply with any such direction as aforesaid requiring the removal, alteration, or concealment of any light, buoy, beacon or other apparatus, the Admiralty may (without prejudice to any proceedings which may be taken in respect of the offence) cause to be done all such work as may be necessary for securing compliance with the direction.

Moroccan Ports

A recently issued Report on Economic and Commercial Conditions in Morocco, published by the Department of Overseas Trade (H.M. Stationery Office, 1s. 3d. net), contains certain references to Moroccan ports which are extracted and given below. The Report is in three sections, dealing respectively with the French Zone, the Spanish Zone and the Tangier (International) Zone. All are compiled by the British Consul and Consul Generals in the country. The Report is dated May, 1939, and follows an earlier report dated 1935-6.

French Zone: Ports.—The Port of Casablanca has undergone no great change since the date of the last report. Public warehouses now cover a total area of 61,000 sq. metres. The existing length of quayside, viz., 3,450 metres, provides berths for about 35 or 40 vessels; this accommodation is considered inadequate, and various plans for extension are under discussion. They include (a) the construction of two new moles within the existing harbour or, alternatively, the lengthening of the present Jetée Delure 250 metres out to sea, and the addition thereto of a transverse jetty; (b) the fitting of a special berth for tankers; (c) the building of a graving dock at the shore end of the Jetée Delure.

A project of some interest now under consideration is the establishment of a free zone in the port. Existing systems of temporary Customs exemption, e.g., the drawback system, would be superseded; certain local industries might be encouraged to carry on manufacture within the free zone, transhipment would be facilitated and, in general, it is hoped that Casablanca would be placed on more favourable terms of competition with neighbouring free ports or ports with free zones.

The following table gives figures for ships entering the Port of Casablanca in 1937 and 1938:—

	1937.			1938.		
	French.	British.	Total.	French.	British.	Total.
Number of vessels	705	251	1,954	723	246	2,107
Net tonnage	2,001,867	702,795	4,272,580	1,963,433	687,784	4,407,464

Casablanca continues almost to monopolise the seaborne traffic of the Zone (and that entering or leaving Morocco by land, via Oujda, forms a very small proportion of the total foreign trade). Although the exports of phosphates from Saffi which began three years ago has raised that port to the second place, Port Lyautey, which serves the agricultural region of the Rharb, is of more general importance. It is a river port, eleven miles from the mouth of the Sebou, and is accessible for vessels drawing up to 17-ft., although a sharp bend in the river limits their length to 350-ft. Work on the beginnings of a port has been put in hand at Agadir, in the form of a jetty 440 yds. long, and its prolongation for a further distance of 900 yds. is under consideration. Rabat remains neglected.

Spanish Zone: Melilla and Ceuta.—A new policy has been initiated with regard to municipal revenue in Sovereign territory. Hitherto, Melilla and Ceuta have been legislated for as purely Spanish ports, and their background has been almost purely and exclusively Spanish. It is now recognised, however, that the background and policy determining the future prosperity and development of Melilla and Ceuta are intimately linked with Spanish Morocco, and should be studied and legislated for from the Moroccan angle rather than the Spanish. The expansion of both ports is conditional upon their identification with Moroccan Zonal policy. Changes have therefore been made in the municipal charges on merchandise passing into and from the Zone through Melilla, and taxation there has been modified to bring it into line with similar taxes existing in the Spanish Zone.

Ceuta aspires to occupy a more important situation in the international maritime world, and to become not only the chief gateway to Spanish Morocco and the clearing house for Moroccan products, but a coaling base and port of call that shall be a challenge to Gibraltar, situated on the opposite side of the Straits.

Tangier Zone: Port.—The main outer mole has now reached a length of 1,020 metres, and no further extension in the immediate future is contemplated. There is a landing quay some 136 metres long between the 664 and 800 metre points on the outer mole. The depth alongside is 9 metres at maximum low water of equinoctial spring tides.

The following tonnage of steamships in the foreign trade entered in the years given:—

1935	3,022,794
1936	2,654,210
1937	2,602,786
1938	2,535,809

Fire Risks at Piers and Wharves in Ports of the United States

The following is a statement recently made by Mr. C. H. Fischer, Chairman of the Committee on Piers and Wharves at the Annual Meeting of the U.S. National Fire Protection Association. It is reproduced from a report in " World Ports," and is illustrative of the difficulties in dealing with fire risks at American ports.

Mr. Fischer said we have encountered many difficulties in effecting better conditions in pier and wharf property. I think these are due largely to the resistance engendered by the economic factor and to the lack of appreciation of the real dangers involved. I recently saw an aerial picture of a section of the North River of New York, on the New York side, covering a distance of about 3,000-ft. There were berthed at some five piers six ocean-going vessels, including the " Normandie." I saw that there was approximately 150 million dollars of value concentrated in a distance of 3,000-ft. In most of the slips there were two vessels. Some of those vessels were unloading, some of them were loading, some of them were preparing to sail. In the slips there were lighters loading cargo from the water side. Bunkering of fuel oil was in progress. Ten or fifteen thousand people were on the ships and piers, including passengers, crew, pier employees and others.

My mind ran from that picture to the analysis I made of that horrible holocaust in Hoboken in the year 1900, when there were four vessels at the piers. There were happy voyagers in their state-rooms and relatives and friends on the piers. A fire flashed from one pier. The reports vary as to the loss of life, from 400 to 900.

And then I thought for a moment of what Chief John J. McElligott said in 1934, when he addressed the American Association of Port Authorities, when there was vividly in his mind that disastrous defeat of the New York Fire Department in endeavouring to conquer the fire in the Cunard Pier. Chief McElligott stated in this paper that he was firmly convinced that the next big fire catastrophe in New York City would be on the water front.

Our fire records continue to reflect a failure to recognise the sharp distinction from the fire viewpoint between the sub-structure and the superstructure of a pier. There are many piers and wharves in the United States and Canada that have automatic sprinklers in the superstructure but none in the sub-structure. This is comparable to a building with one portion sprinklered, connected to another unsprinklered portion. Our records show some six fires where the superstructure was provided with automatic sprinklers, but the sub-structure was not. In a number of cases the sub-structures burned out and the superstructure, the cargo and the sprinkler equipment slid into the harbour. The indifference to this vulnerability may be charged against the owners, the port authorities and the insurance interests. It is beyond my comprehension why the insurance interests do not take more cognizance of this weakness in pier structures.

The Canadian Pacific Railway pier fire in Vancouver, which occurred on July 27th, 1938, is a case in point. That fire resulted in a loss of approximately $880,000. It was sprinklered except in the sub-structure. The reports which I have indicate that the inspection department having jurisdiction at the time when this sprinkler protection was installed in the superstructure, brought all the persuasive arguments at its command to induce the owners to protect the sub-structure. But no.

If we are to bring about any major improvement in this class of property, we have the choice of using persuasion, or of endeavouring to have laws adopted which will require suitable safeguards to protect life and property. Our committee has asked to have the Committee on Laws and Ordinances frame a suggested ordinance to cover this class of property. This was done last year, and the tentative report was returned to us for our consideration. I must confess that the failure to have that report before you at this time is my fault. But I assure you that during the coming year that report will be forthcoming, so far as my committee is concerned. I consider the adoption of such an ordinance the final step in the plan which I have had in mind for a long time for the committee. After the completion of the ordinance, I hope for its adoption in many places as a result of the educational campaign of the Association, with the aid of the inspection departments having jurisdiction and with what I am informed will be co-operative aid from the American Association of Port Authorities.

Port of Glasgow

Clyde Navigation Trustees' Annual Statement

At a meeting of the Clyde Navigation Trustees in Glasgow, on September 6th, Mr. J. A. Ralston Mitchell, finance convener, submitted his financial statement for the year ending June 30th, 1939.

Mr. Mitchell said they had had a less favourable year than the previous one, and their returns had been affected by the general depression in trade which marked the period under review, as was manifested by the fact that revenue was £56,539 less than last year. When, however, it was recalled that last year was overshadowed by international uncertainties and recurrent crises, there was some satisfaction at the relative smallness of the decrease shown. They had to bear in mind that their comparisons were with last year, which was an exceptionally good one, and excluding that year, one had to go back to 1930 to find this year's receipts exceeded.

Revenue was £955,931, against £1,012,470 in the previous year, a decrease of £56,539. Expenditure charged to revenue was £898,194, and showed a saving of £31,767 in comparison with the previous year. Surplus revenue amounted to £57,737, which had been disposed of as follows:—£48,127, which represented full statutory contribution, had been carried to the sinking fund, and the balance, £9,609, placed to the credit of the revenue account.

Revenue from ships at £329,499 showed a decrease of £8,779, while revenue from goods at £304,246 was down by £44,920. There was a further considerable falling-off in receipts from cranes, hoists, etc., of £27,298, all of which were reflected in the downward trend of trade generally. On the other hand, other items of revenue showed an increase of £24,760.

The tonnage of ships arriving at and departing from the port was 15,758,478 tons, which constituted a record, and showed an increase on the previous year of 36,558 tons. In spite of this increased tonnage, however, there was a decrease in the revenue. This was accounted for by the greater number of foreign ships arriving or going out in ballast.

The tonnage of goods imported and exported was 6,189,184 tons, a decrease on the previous year of 1,075,591 tons, and this decrease in goods had, of course, had a serious adverse affect on revenue.

The principal decreases were in iron and steel, which were down 700,000 tons, and coal, which showed a decrease of 150,000 tons.

The graving docks showed a welcome increase of £2,215, and it was worthy of note that at the granary the grain handled was up by 80,546 tons, and revenue showed a substantial increase of £6,837. An addition to the granary was opened in September last, and the increase shown was largely due to this fact.

Regarding capital expenditure, after certain unemployment grants, etc., were deducted, £115,514 had been spent, the chief items being the purchase of the Meadowside shipyard and sawmills at Partick, but in addition, considerable sums for dredging and widening the river had been incurred.

A sum of £24,162 had been spent on granary in connection with an extension which had cost to date £107,268, and a further £10,000 in the current year would, it was anticipated, complete the cost. Additional cranes, capstans and grabs to deal with the increasing mineral traffic at Rothesay Dock cost the Trust £30,700.

The general balance sheet showed that the total money borrowed was £8.536,159, an increase of only £9,297 on the previous year, which was very satisfactory, considering the increased value of their works, plant, etc. The amount of the available borrowing powers of the Trust was, at June 30th, 1939, £2,714,498.

As regarded prospects for the present year, all he could say was that so far as revenue was concerned the year had opened well, and the first two months, July and August, showed an increase of £15,600 over the corresponding two months for last year. They had, however, considerable capital and extraordinary revenue expenditure to meet, estimated to amount to over £100,000, which, however, was about £63,000 less than the previous year's estimate.

CLYDE

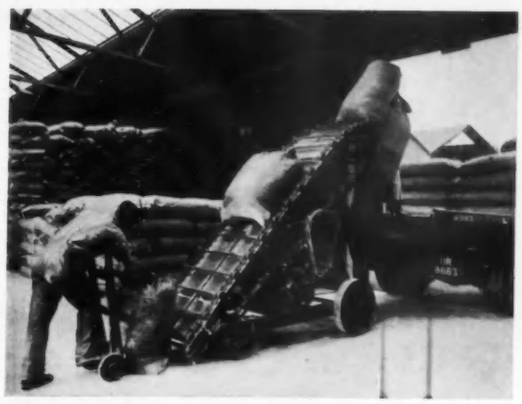
CRANE

&

ENGINEERING COMPANY

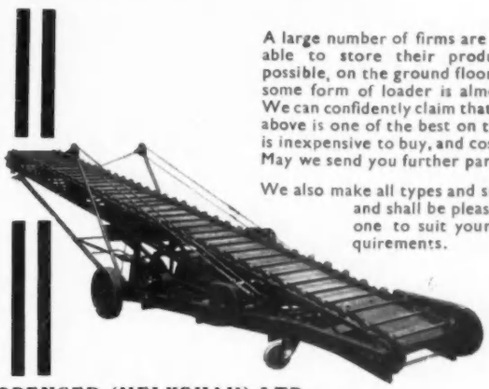
MOSSEND, near GLASGOW

Telephones—Head Office and Works: Motherwell 354-5.
London Office: London Royal 3633.
Telegrams—"Clyde, Motherwell.



SPENCERS

ARE SELLING A LOT OF THESE PORTABLE LOADERS



A large number of firms are finding it advisable to store their products, as far as possible, on the ground floor. In this case some form of loader is almost a necessity. We can confidently claim that the one shewn above is one of the best on the market. It is inexpensive to buy, and costs little to run. May we send you further particulars?

We also make all types and sizes of Stackers and shall be pleased to quote for one to suit your particular requirements.

Send for our Illustrated Booklets

SPENCER (MELKSHAM) LTD.
MELKSHAM, WILTS.

ADVERTISING IN WAR-TIME

Claims of the Technical Press

By PERCIVAL MARSHALL, Executive Chairman, Periodical Trade Press and Weekly Newspaper Proprietors' Association

IT is a remarkable thing that one of the most unexpected reactions on the outbreak of war should have come from those whom we regard as level-headed business men. I refer to the widespread rush to stop advertising in both the periodical and the trade and technical Press, which marked the first few days of the new regime. That rush soon showed signs of subsiding, and in a number of cases cancelled appropriations have been resumed, and even new business has been placed. This is only common sense.

Presumably this panic was dictated mainly by a desire to effect an immediate economy in the conduct of business, and to concel advertising contracts seemed such a simple way of saving money. Actually, this method of economising is a two-edged weapon which cuts both ways. The advertiser's name and the goodwill of his particular product—which he has built up through years of intensive effort—disappears from the consumer's sight immediately. The buying public is left in the dark as to whether the advertiser and his goods are still in existence; his customers wonder whether he is loyally responding to the Prime Minister's definite request that all businesses should carry on, or whether he is on the point of fading out of the commercial picture.

A Business "Black-Out"

By stopping his publicity the advertiser is, in fact, subjecting his business to a "black-out" in his particular market, a definite step backward from which it may take a long time to recover. Business is bound to continue, and both private and general industrial requirements will need to be filled on a large scale. The demand for certain existing goods of special service will be intensified, and new demands of all kinds will arise to meet the new conditions of life. To stop advertising is to cut yourself off from the market, and to say to the readers of the journals you use: "Relations are suspended—we are no longer interested in you." The psychological effect of ignoring your buying public in this way may have far-reaching results. How much better to say to them: "We are carrying on—let us supply your needs."

The public at large will more than ever need appropriate reading material to divert their thoughts from the tragedy of the war, and to occupy their minds and entertain them during the enforced "black-out" hours. The periodical and magazine Press will supply this want effectively, and will continue to give good publicity value.

Trade and Technical Press.

So far as the trade and technical Press is concerned, that two-edged weapon cuts another way. It inflicts definite injury on the journals which render such admirable service with vital news and important trade and technical information. These journals are themselves determined to carry on their service to industry. The stopping of your advertising can only diminish their resources for giving you that news and intelligence service which you must have if you are to carry on yourself. Why not make common cause with them, and help yourself by helping them in these difficult times?

The Press is out to give both readers and advertisers the fullest possible value, consistent with any official restrictions, and it is in your interest to co-operate in the fullest possible measure. Do not "black-out" your business from your market; rather let the searchlight of the buyer be focussed upon it. Above all, let your world know that you are following the lead of the Prime Minister and are loyally "carrying on."

A.R.P.

Expert Construction of Underground Shelters fully or partially Bomb-proof as required.

Shoring up of Basement Areas.

THE FRANCOIS CEMENTATION CO., LTD.
BENTLEY WORKS
DONCASTER

Tel Nos.: **54177/8/9**
Tel. Address: **"Francois, Doncaster"**

LOCOMOTIVE & MOBILE CRANES

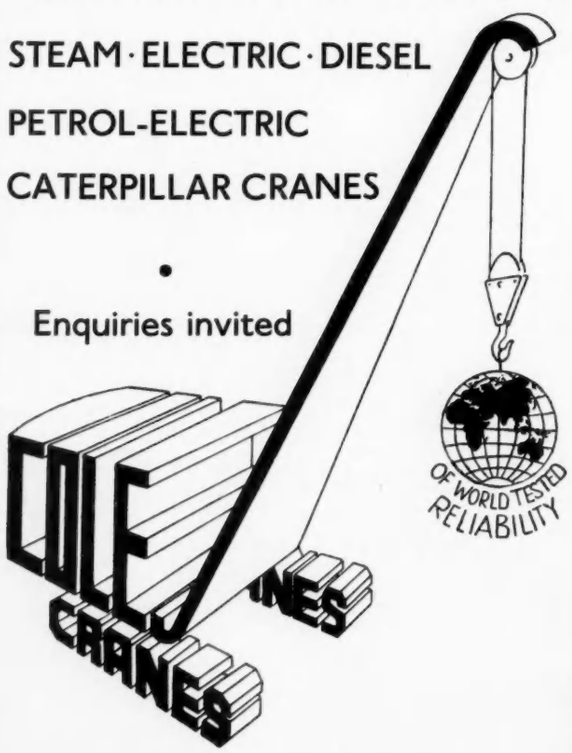
STEAM · ELECTRIC · DIESEL

PETROL-ELECTRIC

CATERPILLAR CRANES

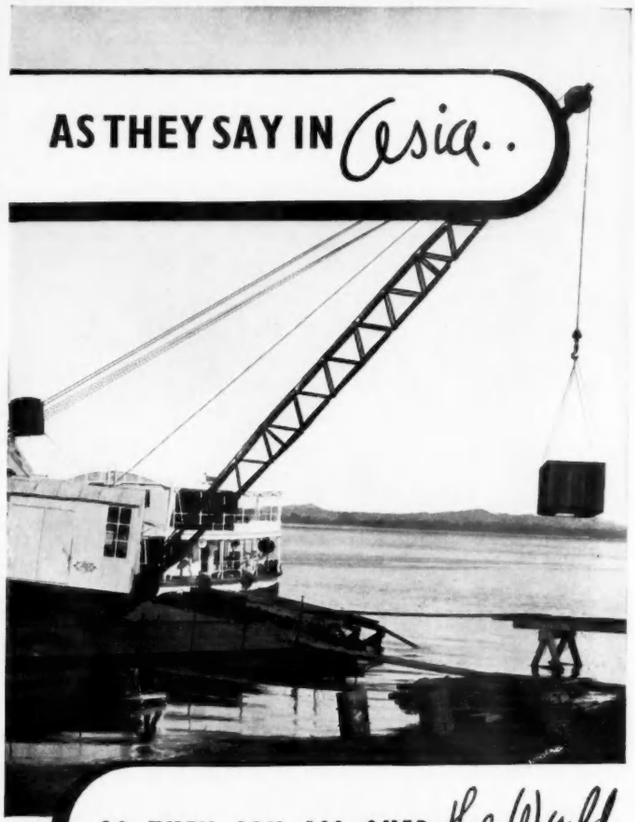
•

Enquiries invited



HENRY J. COLES Ltd., Derby, Eng.
TELEPHONE: DERBY 45436/7 TELEGRAMS: COLES, DERBY
LONDON OFFICE: BUSH HOUSE, W.C.2
TELEPHONE: TEMPLE BAR 3671/2

AS THEY SAY IN *Asia..*



..SO THEY SAY ALL OVER *the World*

★ *(Extract from ———'s diary)*

"Soon afterwards . . . the natives began to unload the cargo with the aid of—believe it or not—a crane! Imagine a steam-crane in this far corner of the world! She looked as if she might have been here for twenty years at least. But she was doing her job all right, lifting and swinging the huge crates in really fine style. I looked for her name-plate and found the well-known word 'Smith' . . ."

All over the world you will find SMITH CRANES doing their jobs dependably.

YOU CAN DEPEND ON

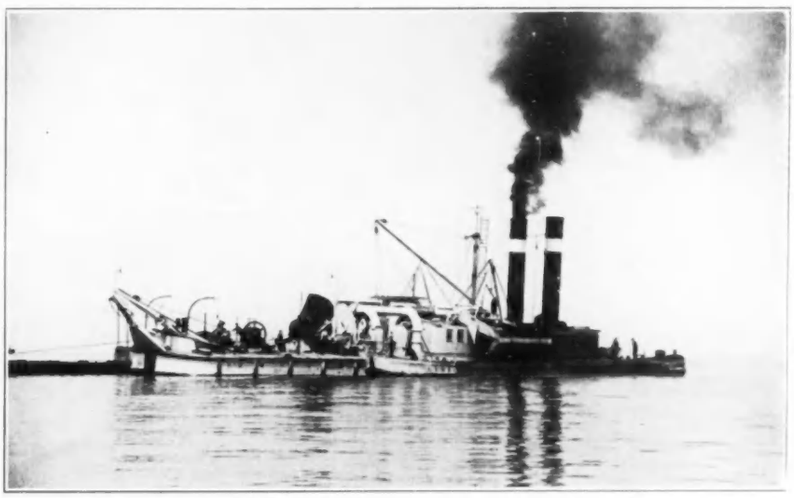
Smith CRANES

Thomas Smith & Sons (RODLEY) Ltd., Rodley nr. Leeds

NASH DREDGING & RECLAMATION Co. LTD

PALACE CHAMBERS, 9, BRIDGE STREET, WESTMINSTER, S.W.1

MODERN DREDGERS AND AUXILIARY PLANT OF EVERY DESCRIPTION FOR SALE AND CHARTER



ESTIMATES GIVEN FREE AND CONTRACTS UNDERTAKEN FOR DREDGING AND RECLAMATION IN ANY PART OF The WORLD

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Dredging into Barges

IN CONNECTION WITH THE ZUIDER ZEE RECLAMATION SCHEME

Telegrams: Deepening, Phone, London

Telephone: Whitehall 2423

On the left is a 15-ton electrically driven Travelling Jib Crane at Grimsby Harbour, characteristic of the

ROBUST AND EFFICIENT

CRANES

MADE BY

Telegrams: "Cranes" Aberdeen | *London Office: 12 Norfolk St. Strand, W.C.2*

JOHN M. HENDERSON & Co. Ltd. KING'S WORKS ABERDEEN

HOPPERDREDGERS

Diesel electric driven trailing suction hopperdredger supplied to the Argentine Government.

J. & K. SMIT

KINDERDIJK-HOLLAND

DIVING APPARATUS OF ALL PATTERNS.

CONTRACTORS TO ADMIRALTY. WAR OFFICE. INDIA OFFICE. CROWN AGENTS. TRINITY HOUSE. ETC.

ALSO MAKERS OF

SMOKE HELMETS

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